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Correspondence.—Wishing to make this JOURNAL a gazette of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, correspondence is solicited for publication from all who make the study of those subjects a pleasure or a profession.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

Thirty-eighth Annual Meeting, New England Association of Gas Engineers.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS,
OFFICE OF SECRETARY,
EAST BOSTON, MASS., Feb. 5, 1908.

To the Members of the New England Association of Gas Engineers:

The Thirty-eighth Annual Meeting of the New England Association of Gas Engineers will be held in Young's Hotel, Boston, Wednesday and Thursday, February 19 and 20, 1908. The following papers will be presented:

"The Readiness to Serve Costs of Gas Supply," by Mr. Wm. H. Gardiner, New York.

"A Reinforced Concrete Oil Tank Building: Design, Construction and Cost," by Mr. Chas. F. Leonard, Fall River, Mass.

"Maintaining Mantle Lights," by Mr. N.W. Gifford, E. Boston, Mass.

"Filling Balloons with Coal Gas," by Mr. H. C. Crafts, Pittsfield, Mass.

"Report of Committee on Actual Accounting and Depreciation."

Questions.—"What new and successful devices are being used to extend the gas business?" "How has benzol enrichment withstood low temperatures in New England?" "How can breeze and other low burning fuels best be burnt?" "What has experience to date shown to be the comparative merits of Inclines, Machine-operated, Double-ended, and Vertical retort systems?" "What is the net result of the increasing use of pilot lights?"

Members having suggestions or questions which they wish discussed at the meeting will please forward them at once to the Secretary. Applications for membership should be sent to the Secretary as soon as possible, and should be accompanied by the initiation fee.

Members will dine together as usual, Wednesday evening, at 6:30 P.M. Friends of the Association are cordially invited to attend the meeting whether receiving formal invitation or not.

N. W. GIFFORD, Secretary.

BRIEFLY TOLD.

THE NEW ENGLAND ASSOCIATION'S MEETING.—Nothing has been left undone that should have been done for the insuring this week of a completely successful meeting of the New England Association of Gas Engineers by its executives, so it is up to the members as a body to make the proper recognition of that which their officers have thoughtfully planned. From what has been said by many visitors to the JOURNAL office the past fortnight we will here venture the prediction that, from an attendance standpoint, the 38th meeting of the New England gas men will be the most notable of all the meetings of the Mother Association; and that is claiming much. The paper list set out by Secretary Gifford is an attractive one, and it may also be pointed to that it has one paper on a subject that has never been treated formally by any of our American gas bodies. This original subject is to be attacked by Mr. H. C. Crafts, of Pittsfield, Mass., in his narration concerning the "Filling of Balloons with Coal Gas." This branch of the trade is certain to take on greater importance each year, for ballooning in its relation to warfare has reached the truly important point. To those who would doubt this we have only to say that the already considerably large practical interest taken by our National Government in the development of this adjunct to warfare is but as the prelude is to the finished score. A study of the matters committed to the Question Box surely goes to show that this feature of the New England's meetings is even more prominent to-day than it was when the plan was originally tried by the Association well over a score of years ago. Of a certainty, the New England Association is not satisfied with mere living; it grows, and sturdily, too.

BUREAU OF INFORMATION, AMERICAN GAS INSTITUTE.—Supplementing our information in issue of JOURNAL for the 3d inst., as to the future operation of the Bureau of Information, American Gas Institute,

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which clearly outlines the method of working established by the Bureau, it may be here added that the members of the Bureau are: W. A. Baehr (Chairman), W. H. Gartley, R. B. Brown, W. E. McKay, J. D. von Maur, H. L. Rice, F. W. Frueauff, E. H. Earnshaw and John M. Rusby. Chairman Baehr's address is 716 Locust street, St. Louis, Mo. It was only at the urgent solicitation of Mr. Gartley that Mr. Baehr consented to act as Chairman, and it is now up to us all to help out in the work that the Bureau has undertaken to supervise. Of course, it is best, wherever possible, to send the questions that are asked direct to Chairman Baehr, which method will greatly simplify the operations of the Bureau.

MEETINGS ENDED AND TO BE HELD.—The first meeting of the Power Section of the American Society of Mechanical Engineers was held last Tuesday evening in the hall of the Engineering Societies' Building, 39 West 39th street, New York, and if the first may be fairly taken as an example of that which is to follow, the Society is to be congratulated on its new line of policy. The attendance was excellent, both as to numbers and authority, and the proceedings were of the briskest sort. The set subjects were: "Experimental Gas Turbines in France," which was rendered doubly interesting by a well handled series of lantern slides; "A Simple, Continuous Gas Calorimeter;" and "A Gas Engine and Producer Guarantee." Naturally, the last named was provocative of a spirited discussion. The discussion also included extended debate on the question of Gas Power in general.

The last regular meeting of the Chicago Section of the Illuminating Engineering Society was also a record maker for attendance and interest. The proceedings were prefaced by a dinner served in the Breakfast Room of the Grand Pacific Hotel, at 6 P.M. of the 13th inst., which was enjoyed by the members in hearty, informal style, and later on Dr. H. H. Seabrook's paper on "Effects of Light upon the Eye," was liberally discussed. The debate was rather on the technical order, but it nevertheless was spirited, owing to the fact that several prominent oculists were especially present to take part therein. The Secretary (Mr. George H. Jones) is to be complimented on the excellent way in which the preliminaries where thought out and acted on.

The next meeting of the New England Section of the Illuminating Engineering Society is most happily arranged, in that it is fixed for 8 P.M. of to-morrow, at which time Boston will hold many delegates ready for the sessions of the New England Association of Gas Engineers, which are called for the next morning. The meeting place is the Edison Building, 39 Boylston street, and the paper is to be the result of the studies of Mr. L. W. Marsh, of the American Luxfer Prism Co., on "Daylight Illumination." All visiting gas men are invited to take part in the session.

CURRENT COMMENT.—

MR. HOWARD E. MANN, whose lengthy, active and successful connection with the Cleveland (O.) Gas Light and Coke Company, especially in the engineering department thereof, is well known to the fraternity, has resigned from its service.

A NOTABLE happening last week was the holding in Wilkes-Barre, Pa., of a celebration commemorating the centennial time mark of the first anthracite grate fire that was set up in the neighborhood of Wilkes-Barre by Jesse Fell a century ago.

LAST week the Managers of the various gas properties controlled by Messrs. Edward M. Deane & Co., met (in convention virtually) in the offices of the Company in the Murray Building, Grand Rapids, Mich. The meeting took up the larger part of the business hours of the 11th, 12th, and 13th insts., and it is needless to say that the time thus spent was well spent. A feature of the social side was a banquet in the Hotel Pantlind, the evening of Thursday last. It was the first meeting of this nature held by the Deane Company's active forces, and it was really in the nature of a tentative one—if the outcome was sufficiently valuable the practice was to become an annual one—to that, of course, there could be only one result. The meetings will be continued.

IT is understood that Mr. Giuliermo Dominguez, of Los Angeles, Cal., is arranging for the construction of a gas plant in Guadalajara, Mexico, the concession under which he is to operate having been secured by him last spring. It is estimated that an expenditure of $300,000 in gold will be necessary, and the practical part of the enterprise is in the hands of Mr. H. U. Sessions, who left Los Angeles about a fortnight ago to remain in Guadalajara until all the requisite preliminary steps to the work in hand have been completed.

[Continued from page 231.]

PROCEEDINGS AMERICAN GAS INSTITUTE, SECOND ANNUAL MEETING, HELD AT THE NEW WILLARD HOTEL, WASHINGTON, D. C., OCTOBER 16, 17 AND 18, 1907.

THIRD DAY—MORNING SESSION.

A BULLETIN OF INSTRUCTIONS ON THE CARE AND OPERATION OF RECUPERATIVE BENCHES.[1]

"To obtain a producer gas of as high a heat value as possible—that is, containing a large amount of carbon monoxide (with the increase of the amount of CO the amount of N_2 decreases at the same time, so that the heat value of the gas is increased from both sources), it is requisite that—

"1. The temperature of gasification must be high when the amount of oxygen in the primary air remains constant. However, in practical operation, a temperature of 700° to 900° C. is sufficient, because at these temperatures the maximum amount of carbon monoxide has been nearly attained.

"2. With high temperatures of gasification the quality of the generator gas increases (its amount of carbon monoxide increases) with the amount of oxygen contained in the primary air.

"3. High blast pressures are unfavorable because the amount of carbon dioxide is increased (assuming all other conditions the same).

"If, however, one desires to generate in the producer as large an amount of carbon dioxide as possible, as might be the case during the 'blow' of the water gas process to obtain a very quick rise in temperature, this is only possible (assuming that the equilibrium is to be reached) with very low temperatures, because with rising temperatures the amount of carbon monoxide increases rapidly, and the amount of carbon dioxide decreases.

"Should the condition of equilibrium actually be attained in the producer it will not be possible to obtain a high generator temperature; that is, if the producer is being operated with a view of obtaining as large an amount of carbon dioxide as possible. Neither would an increase in the amount of oxygen in the primary air alter these conditions.

Water Gas.—"Instead of generating the combustible gases by permitting oxygen contained in the air to come into contact with incandescent carbon, we can utilize the oxygen contained in water. If steam is brought into contact with incandescent carbon two different reactions take place, according to the temperature.

"With very high heats the decomposition takes place according to the equation:

$$C + H_2O = CO - H_2$$

while as the temperature falls there comes into play, to a greater and greater extent, a second reaction expressed by the equation:

$$C + 2H_2O = CO_2 + 2H_2.$$

"The first equation furnishes a mixture of equal volume of carbon monoxide and hydrogen; therefore a gas of the following composition:

Carbon monoxide.....50 per cent. by volume.
Hydrogen.....50 " " "

"The second reaction, when appearing alone, furnishes a gas that has for 1 volume of CO_2, 2 volumes of hydrogen, and whose composition would be:

Carbon dioxide.....33.33 per cent. by volume.
Hydrogen.....66.67 " " "

"The thermal value of the first gas equals per 22.42 liters 68 cal., while the thermal value of the second gas is only 45.4 cal.

"A comparison of the air gas process with the two water gas processes results as follows:

No.	Process.	Composition in Per Cent. by Volume. H_2	CO	CO_2	N_2	Thermal Value per 1 Molecule of Gas Mixture with Constant. Vol. Cal	Press. Cal
1	$C + \frac{1}{2}(O_2) + 2N_2 = O + 2N_2$	....	33⅓	....	66⅔	22.6	22.9
2	$C + 2H_2O = CO_2 + 2H_2$.....	66⅔	....	33⅓	....	45.4	46.5
3	$C + H_2O = CO + H_2$.....	50	50	....	....	68.0	68.5

"The thermal values refer to equal gas volumes, and are, therefore, especially well adapted for the comparison of quantities of gas. If it is desired, however, to take into consideration the efficiency of the combustibles, it is necessary to refer the thermal value to equal amounts of carbon (equal volumes of CO and CO_2) and we would then have the following:

1. For the opening chapters of this paper, see JOURNAL, *ante*, p. 231.

No.	12 Grammes Carbon Equal Liters of Gas.	Thermal Value of the Gas with Constant. Volume Cal.	Thermal Value of the Gas with Constant. Pressure. Cal.
1	67.26	67.8	68.7
2	67.26	136.2	139.5
3	44.84	136.0	137.0

"As will be observed, water gas even in the worst case results in a far greater thermal value than the ideal air gas, to which is to be added that it contains a far smaller proportion of incombustible gases.

"If we desire to carry the comparison completely through, it will be at least necessary to determine the theoretical amount of air required for combustion (although it is not necessary to determine the pyrometric effect—that is, the theoretically attained combustion temperature). For each 22.42 liters gas we require:

	Composition of the Gas in Per Cent. by Vol.				Theoretical Amount of Air.		Gases. Combustible.	Gases. Inert.	Products of Combustion		
	H_2	CO	CO_2	N_2	O_2	N_2			H_2O	CO_2	N_2
1	...	33⅓	...	66⅔	16⅔	64⅔	33⅓	131⅓	...	33⅓	66⅔
2	66⅔	...	33⅓	...	33⅓	133⅓	66⅔	166⅔	66⅔	33⅓	133⅓
3	50	50	...	...	50	200	100	200	50	50	200

"As the decomposition of water requires more heat than is generated by the formation of carbon monoxide, or even carbon dioxide, both water gas processes can only be carried to completion by securing heat from an outside source. For we have:

$C + \frac{1}{2}(O_2) = CO + 21{,}100$ cal.
$C + 2H_2O = CO_2 + 2H_2 + 97{,}600 - 138{,}000 = CO_2 + 2H_2 - 40.4$ cal.
$C + H_2O = CO + H_2 + 26{,}100 - 69{,}000 = CO + H_2 - 42.9$ cal.

If we take this supply of heat into consideration we have:

Process.	Thermal Value of the Gas per 12 Grm. Carbon. Cal.	Amt. of Heat to be Supplied from Outside Sources. Cal.	Gain in Heat. Cal
$C + \frac{1}{2}(O_2) + 2N_2 = CO + 2N_2$.	68.7	−21.1	89.8
$C + 2H_2O = CO_2 + 2H_2$.....	139.5	+ 40.4	99.1
$C + H_2O = CO + H_2$.....	137.0	+ 42.9	94.1

"The absolute gain in heat in water gases is not a large one, and becomes smaller when we consider the heat losses due to supplying the necessary amount of heat in the producer. The superiority of water gas does not, under any circumstances, consist in a gain of heat, but in the fact that a gas of greater thermal value is obtained, and because it is possible to utilize the heat of combustion to better advantage.

"As can be seen from the above considerations, the first process which takes place, when steam is brought into contact with a layer of incandescent carbon is, according to the equation, C H_2O = CO + H_2. But as heat is absorbed by this process (endothermic reaction) the layer of carbon will cool and there will appear simultaneously with the first process a second one, $C + 2H_2O = CO_2 + 2H_2$.

"As the cooling proceeds the second reaction becomes more pronounced, until finally the carbon in the generator becomes so cold that the process comes to a standstill, and the steam introduced into the layer of carbon passes through undecomposed. This makes it necessary to reheat the carbon contents of the generator, which is accomplished by shutting off the steam and permitting air to be blown through it (generating air gas, that may be collected and utilized independently) until the fire is again sufficiently heated. This is called the 'blow.' After this has been accomplished, the blast is cut off and steam turned on again (run) until the temperature has dropped so low that the water gas process does not take place economically.

"Therefore, we are obliged to deal with an intermittent process, which not only requires careful attention, but which also necessitates the erection of at least double the number of generators, where continuous production is requisite, and a gasholder is undesirable.

"As we have seen, both water gas processes take place simultaneously, but as one results in a far better gas and better fuel efficiency, it is important to know the conditions under which decomposition proceeds in both processes. For this purpose we will study the conditions of equilibrium between both reactions. To establish the equilibrium in the gaseous condition, it is first necessary to find a reaction between the constituents of each. We find such simply by subtracting the reactions

$$C + H_2O = CO + H_2$$
and
$$C + 2H_2O = CO_2 + 2H_2$$

from each other. In this manner we secure the following reaction:

$$CO_2 + H_2 \rightleftarrows CO + H_2O.$$

"This is a reversible reaction, in which we secure 2 volumes ($CO_2 + H_2$) from 2 volumes ($CO + H_2O$) which are independent of their pressure at such temperatures where water appears as steam (and these are the only ones we can here consider). We could surmise that the composition of water gas under given temperatures would be independent of the pressure. This, however, is not the case, as the following observation will show, from the last reaction the isothermic equilibrium:

$$K_1 = \frac{C_{CO}\, C_{H_2}}{C_{C_2O}\, C_{H_2}}$$

or

$$\frac{C_{CO}}{C_{O2}} = K_1 \frac{C_{H_2}}{C_{H_2O}}$$

"Therefore, at any given temperature, any proportion of $CO : CO_2$, corresponds to another proportion of $H : H_2O$. To arrive at definite results we must find a reaction which establishes the equilibrium between the gaseous constituents, which in this case consists of CO, H_2, H_2O, and the solid C, and as such we will choose the equation used in the air gas process:

$$CO_2 + C \rightleftarrows 2CO.$$

For this we can substitute

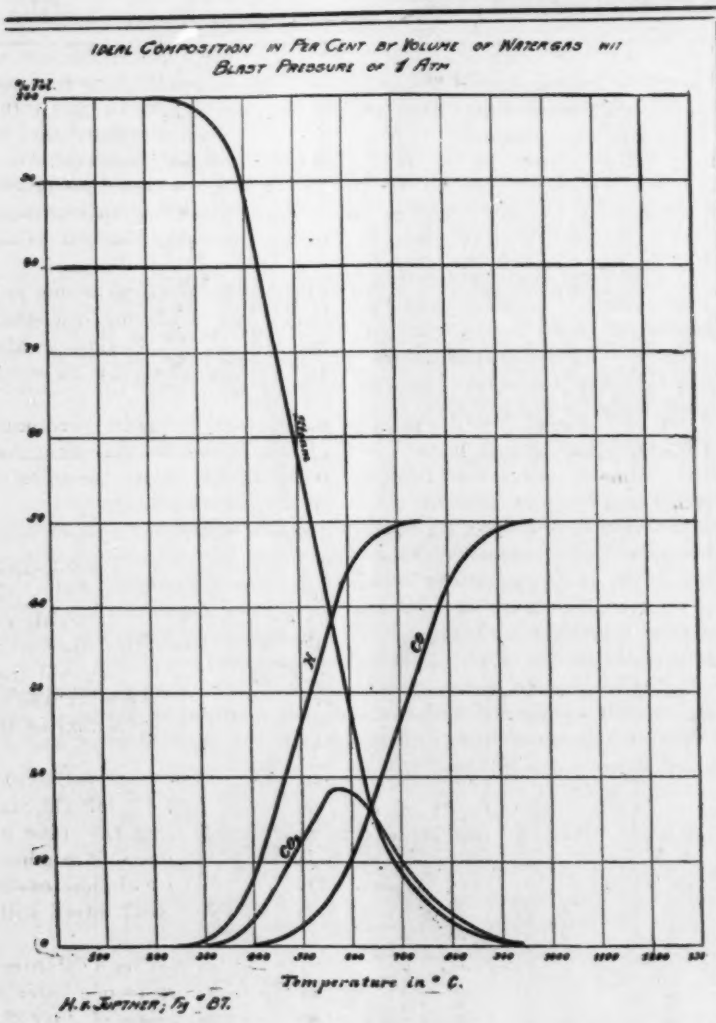
$$K_2 = \frac{(C_{CO}{}^2)}{C_{CO_2}}$$

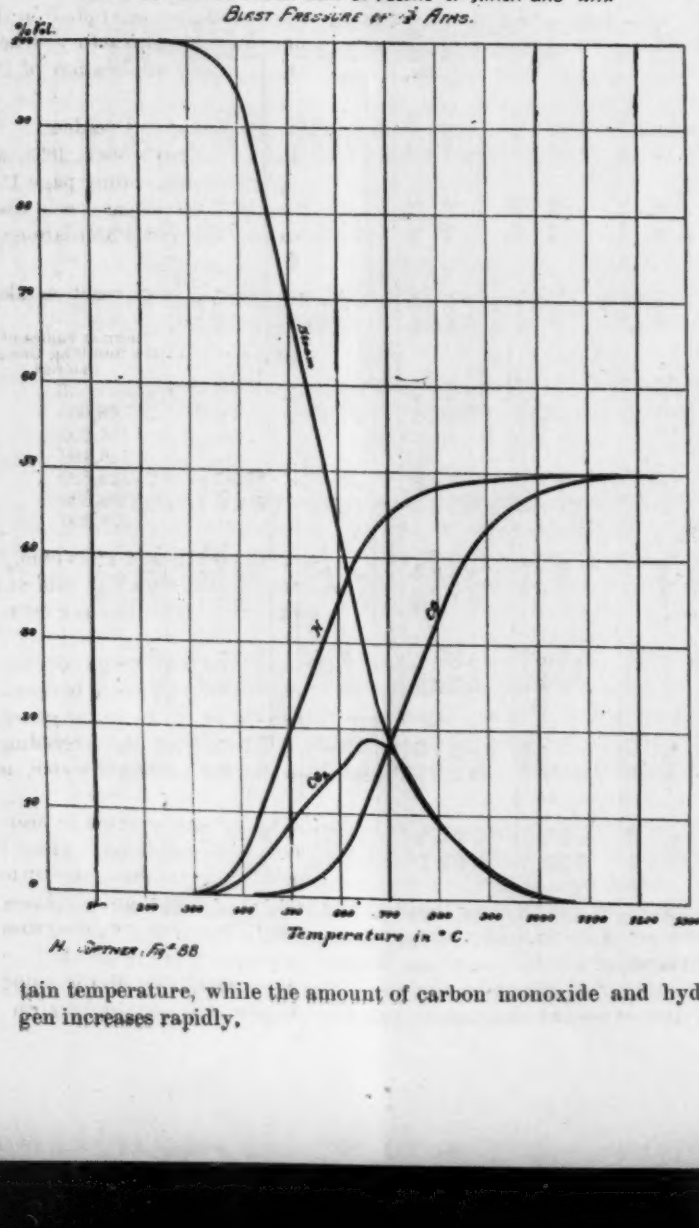
and now the conditions for establishing the isothermic equilibrium are given. As this last reaction is dependent on the pressure, it follows that the composition of the water gas is dependent upon the pressure. The theory of the water gas process has been thoroughly discussed previously (Jüptner, "Phys. Chemistry,") and it will suffice to give the results of such a theoretical research:

"Expressing the steam pressure with H, and the temperature of gasification in degs. C) with t, the ideal composition of the water gas—that is, the composition corresponding to the attained condition of equilibrium—is as follows:

	% by Volume	STEAM PRESSURE (H) IN ATMOSPHERES						
	0.1	0.25	0.5	0.75	1.0	1.5	2.0	2.5	3.0	4.0	5.0	10.0
						t = 400° C						
CO	0.24	0.12	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00
CO_2	10.88	7.86	5.97	5.04	4.46	3.73	3.37	2.97	2.73	2.40	2.15	1.55
H_2	21.99	15.84	11.99	10.12	8.94	7.48	6.56	5.94	5.47	4.82	4.31	3.11
H_2O	66.88	76.18	81.98	84.80	86.57	88.77	90.15	91.08	91.79	92.77	93.53	95.34
						t = 600° C						
CO	26.66	18.87	14.65	11.56	10.03	8.14	6.99	6.20	5.61	4.78	4.22	2.87
CO_2	12.84	16.06	17.15	17.79	17.86	17.67	17.41	17.12	16.84	16.32	15.88	14.32
H_2	52.34	50.89	48.95	47.14	45.75	43.48	41.81	40.44	39.29	37.42	35.99	31.51
H_2O	8.16	14.18	19.25	23.51	26.36	30.71	33.79	36.24	38.26	41.48	43.91	51.30
						t = 800° C						
CO	49.04	47.81	46.04	44.46	43.06	40.56	38.53	36.83	35.41	32.81	30.09	24.38
CO_2	0.50	1.13	2.02	2.80	3.48	4.66	5.59	6.34	6.95	8.02	8.88	11.05
H_2	50.03	50.07	50.08	50.06	50.02	49.88	49.71	49.51	49.21	48.85	48.45	46.48
H_2O	0.43	0.99	1.86	2.68	3.44	4.90	6.17	7.32	8.43	10.32	11.98	18.09
						t = 1000° C						
CO	50.00	49.42	49.42	49.00	48.57	48.35	47.98	46.24				
CO_2		0.25	0.25	0.45	0.61	0.71	0.87	1.59				
H_2	50.00	49.92	49.92	49.90	49.79	49.77	49.72	49.42				
H_2O		0.41	0.41	0.65	1.03	1.17	1.43	2.75				
						t = 1200° C						
CO	50.00	50.00	50.00	50.00	50.00	50.00	49.32	49.31	49.31			
CO_2							0.35	0.35	0.25			
H_2	50.00	50.00	50.00	50.00	50.00	50.00	49.82	49.80	49.80			
H_2O							0.61	0.64	0.66			
						t = 1400° C.						
CO	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00			
CO_2												
H_2	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00			
H_2O												

"Figs. 87 and 88 show the ideal composition of water gas at a steam pressure of 1 atm. and 4 atm. in diagrammatic form. In general the tendency of the curves, under increasing pressure, is towards higher emperatures. Furthermore, these diagrams show that the amount of undecomposed steam decreases very rapidly commencing at a cer-





tain temperature, while the amount of carbon monoxide and hydrogen increases rapidly.

"In the middle portion of the last two curves they are nearly parallel, but the hydrogen curve commences to rise at about 200° C. prior to the carbon monoxide curve. Simultaneously with the hydrogen curve the carbon dioxide curve commences to rise (although slowly) until it intersects the steam curve, and then drops practically simultaneously with it.

"From this we find, for practical operation, that the most favorable gasification temperature lies somewhere within a temperature interval of about 200°, and increases with the steam pressure."

The foregoing extract from Jüptner's "Treatise" may appear somewhat out of place, but I do not consider it in that sense, because it may become applicable in separate producer installations.

In addition to these extracts from Jüptner's admirable book I will refer anyone desirous of delving into these questions to a paper entitled, "Steam in Gas Producer Practice; An Investigation on the Use of Steam in Gas Producer Practice," by W. A. Bone, D.Sc., Ph.D., F.R.S., Professor of Applied Chemistry (Full and Metallurgy), Leeds University; and R. V. Wheeler, M.Sc., late Dalton Scholar and Research Fellow of Manchester University; Chemist to Messrs. Monk, Hall & Co., Ltd., Warrington, England. This paper is published in the AMERICAN GAS LIGHT JOURNAL, June 3, 1907, and concluded in the issue of June 10, 1907.

I will also quote from a letter I received from Dr. J. Bueb, of Dessau, Germany, under date of July 27, 1907, as follows:

"In regard to the reactions which take place in producers—whether carbon and oxygen burn directly to carbon dioxide, whether the carbon dioxide is subsequently dissociated, or whether slow combustion takes place first to CO and then to CO_2—these are matters about which scientists are not yet agreed. These reactions probably all take place simultaneously, and whatever reaction predominates is probably largely dependent upon the temperature."

In connection with the use of water or water vapor under gas producers, I wish to insert a table kindly furnished me by Mr. A. H. Strecker, of Newark, N. J. This table was compiled by Dr. H. Bunte, of Karlsruhe, Gemany, and shows the effect of water vapor upon secondary combustion and temperature of same. The calculation is made from the known flame temperature of the gases under consideration. Dr. Bunte's figures mean simply the elevation of temperatures by the combustion of these gases, above those of the fuel and air supplied to the furnace. In practice these temperatures will be much less, owing to radiation, cooling influence of charges, excess of air supplied, and other causes. The figures are based upon the exact theoretical amount of air required.

Dr. Bunte assumes the air for primary combustion to have a temperature of 500 C., or 932° F., and that for secondary combustion a temperature of 1,000° C., or 1,832° F. His results are figured on the basis of a "Munich" furnace, where the steam needed is entirely produced by evaporation of water by the flue gases. The ashpan is covered so that the fire looses none of its heat by radiation into the water contained therein. Dr. Bunte's tabulated results are as follows:

How Operating.	Initial Temp. in Gen. Deg. F.	Initial Temp. in Combustion Chamber, with Secondary Air. Deg. F.	Deg. F.	Distribution of Primary and Secondary Air by Volume. Primary.	Secondary.
1. Without steam.....	2,640	4,937	5,770	1	1
2. With steam, 1 C to 0.42 H_2O — primary air cold.....	1,284	4,617	5,604	0.72	1.28
3. Do. primary air at 932° F.....	1,870	4,897	5,884	....	....
4. With steam 1 C to 0.567 H_2O — primary air 932° F.....	1,267	4,751	5,801	0.62	1.38

See *Journal fur Gasbeleuchtung*, No. 15, of 1901.

Return Flue Gas vs. Steam as Methods for Clinker Prevention and Fuel Economy.—Probably no more fascinating study in connection with producer work can be found than that relating to fuel economy. Closely related to this we find the subject of clinker prevention naturally affiliated with fuel economy. Any discovery or invention tending towards greater economy in fuel consumption, or which absolutely and cheaply disposes of clinker formation, is surely to be reckoned among the good things that come to mankind. The formation of clinkers is dependent upon temperature. The silicon, calcium and iron constituents of any given fuel are largely responsible for the clinker formation, and it results from the fusing or fluxing of the slug. Heretofore water or steam has been used to keep down the temperature of the fire, and it has fulfilled its purpose with varying degrees of satisfaction. Of late years, however, certain other

methods for clinker prevention have made their appearance, among the most prominent of these being the return of a portion of the waste products of combustion under the fire.

This returning of a portion of the waste products of combustion under the fire is a subject of considerable importance just now. I am frank to say that I do not believe a strictly up-to-date discussion of retort house practice can be written now, leaving this matter out of consideration. I will, therefore, give such results of the use of this method as I have been able to secure both abroad and in this country, and will give such a portion of its history as may be of interest in this connection. At this time I wish to say most emphatically that my statements are to be received strictly in the sense that my discussion is to be upon the merits of the case, and is not to be considered or interpreted in any way as reflecting upon the validity or non-validity of any of the patents involved. What we wish to know is what merit there is to the method; the facts, if they can be secured, and that is all.

In the first place we will look into some of the history of these ideas. I am naturally unable to go into this matter very deeply for lack of time, and because I do not believe we could gain very much exact knowledge from the experience with this or similar methods in the early stages of their exploitation. Referring, first, to the 1901 Edition of "Die Gaserzeuger und Gasfeuerungen," by Ernst Schmatolla, we find, on page 80, the beginning of a chapter on the Siemens' regenerative furnace. This chapter describes the standard regenerative construction as invented by Friedrich Siemens in 1856. Following this chapter is one headed, "The New Siemens Furnace with Chemical Regeneration." This latter chapter begins on page 87, and in the second paragraph we find a statement that a certain furnace is illustrated in this chapter after the latest patent of the "Aktiengesellschaft für Glasindustrie, formerly Friedrich Siemens" in Dresden, as per patent No. 114,531. Quoting the paragraph following we have:

"In addition to the location of the generators in contact, or next to the furnace, a considerable saving in fuel is said to be effected in this style of construction by the introduction of a portion of the hot waste gases, which is again passed through the gas generator. Since the products of combustion consist mostly of carbon dioxide, water vapor, and nitrogen, the carbon dioxide and water vapor are reduced as per the following formulæ:

$$CO_2 + C = 2CO.$$
$$H_2O + C = H_2 + CO.$$"

Thereupon there follows a specific description of this particular type of Siemens regenerative furnace (I am using the term "regenerative" advisedly) with drawings. The portion of the hot waste gases to be returned to the producer is shown and described as being taken off before these waste gases enter the regenerator, and as forced under the grates by means of jets or injectors (kind not stated). Separate jets or injectors are provided for introducing other primary air. The first named jets are stated to be so arranged that the introduction of the waste products under the fire, or of hot air from the regenerators, can be brought about. No results are stated, and all one can learn from this chapter is the fact that Siemens used this method, and it is stated that a considerable saving in fuel resulted.

Going back somewhat earlier in the history of these methods, we find that a patent was issued to Friedrich Siemens, of Dresden, Germany, June 17, 1891; D. R. P.,[1] 69,651, from which the following "patent claims" are translated:

"1. A gas generating furnace in which the products of distillation from the upper layers of the firing material are conducted from the charging spout 'T' to a special chamber 'B,' where they are burned with air brought into this chamber; whereupon the hot mixture of gases and vapors is forced to and under the gas producer itself by means of a steam jet.

"2. A gas generating furnace of the above mentioned construction, in which, for the purpose of saving fuel, a stream of gas containing hot carbon dioxide (for example hot products of combustion) is conducted to the chamber 'B' in place of air."

Thereupon there follows a description of the process. In the first place it is distinctly set forth that only a portion of the total gas generated is conducted to the chamber "B," to be burned, and then forced under the producer by means of a steam jet. Siemens claims that gases that can be condensed, such as water vapors, tar or lampblack, which are so detrimental in ordinary producer gas, exist only in very small quantities in this method. It is also distinctly stated that the highly heated carbon dioxide, steam and nitrogen resulting from the combustion in the chamber "B" are used for the generation of gas in the fuel bed instead of cold air. It is again stated that the hereby occasioned saving must be looked upon as a considerable one, especially where a fuel of low value is used, but it is said the process is not so advantageous where good coal is used. A separate steam jet is provided to force air under the fuel bed when required. Coke or coal can be used.

The gist of the last named patent of Siemens seems to be that producer gas is to be burnt and forced under the generator by a steam jet, and that also a stream of gas containing carbon dioxide can also be led to the producer, but the means of so doing appears to be distinctly stated as a steam jet.

In the "Handbuch der Chemischen Technologie,' by Dr. Ferdinand Fischer, 1900 Edition, Book I., on page 41, we find the statement that Fr. Siemens proposes to use the carbon dioxide of the products of combustion to gasify carbon by means of the equation

$$C + CO_2 = 2CO.$$

It is here stated that about one-half of the products of combustion is blown into the gas producer. Such a construction is said to be installed in the Pather Iron and Steel Company's works, in Frishaw. In the description it is further stated that the waste gases are forced under the furnace by means of jets or injectors. It is also said the statement that large savings in fuel are made is very doubtful, and it is also stated that the entire process is such that the question of its advantage over other methods is still to be proved.

In the book by the same author, year 1893, entitled "Jahres-Bericht über die Leistungen der Chemischen Technologie," pp. 111, 112, 113, 114, we find several calculations and statements concerning the value or non-value of the method of returning the waste products of combustion which contain carbon dioxide. The gist of the calculation results in the statement that it is better to use water vapor well mixed with air than to use waste gases.

I will give a translation of the calculations in Fischer's "Jahres-Bericht" for 1893, but before doing so wish to quote from a letter I received from Dr. J. Bueb, Dessau, Germany, under date of July 27, 1907:

"The introduction of waste gases under a fire, as applied in the glass industry by F. Siemens, has not proved satisfactory where applied in gas works to date, on account of the complication of the proceeding."

Dr. Bueb then refers me to F. Siemens Company, in Dresden.

Returning now to the calculation in Dr. Fischer's book, 1893, we have the following extracts, beginning page 107 and ending page 114. Remember that the metric system of weights and measures is used throughout the German calculations—extracts from "Calculations," Dr. F. Fischer's "Jahres-Bericht," 1903:

"In order to gasify carbon the following well-known reaction takes place:

Reaction No.	Heat Developed. Calories	Thermal Values of the Resulting Gases. Calories.
1. $C + O_2 = CO_2$	97,000	0
2. $C + O = CO$	29,000	68,000
3. $C + CO_2 = 2CO$	39,000	136,000
4. $C + H_2O = CO + H_2$	39,400	136,400
(Water vapor from 20°)	28,600	125,600
5. $C + 2H_2O = CO_2 + 2H_2$	39,800	136,800
(Water vapor from 20°)	28,200	125,200

This means that, taking equation No. 2, 12 kg. C., and 11.15 cbm. O (with 41.95 cbm. N), or 53.1 cbm., resulted in 22.3 cbm. CO, and 64.2 cbm. of mixed gas of the following composition: CO, 34.7 per cent.; N, 65.3 per cent.

"This equation, with the foregoing quantities of material, produces or sets free 29,000 heat units, which gives the gases a temperature of approximately 1,500°, not considering the losses in the generator. The application of carbon dioxide from the preceding equations appears to result about the same as that of liquid water, as per equations 3 and 5.

"It is to be noted that the temperature in a producer must be practically 1,000° C. to allow the reactions shown in equations 3, 4 and 5 to take place. In order to keep the temperature in the generator up to about 1,000° it is necessary to expend about 19,000 heat units. There is thus available about 10,000 heat units left over for use otherwise from reaction No. 2.

"Since the application of equations 3 and 5 result about the same in heat developed and thermal capacity, we can only use one CO_2 (eq. No. 3) for every 4 reactions No. 2 as follows:

1. Imperial German Patent.

4 No. 2 = 4 C + 4O = 4CO.
1 No. 3 = C + CO_2 = 2CO, or combined these result in 5C + 2O_2 + CO_2 = 6CO.

"The resulting gas has the following composition:

	Cbm.	Per Cent.
Carbon monoxide	133.8	44.3
Nitrogen	167.8	55.7
	301.6	100.0

'Sixty kilograms carbon, therefore, result in 301 6 cbm. gas of 408,000 heat units thermal value, about 84 per cent. efficiency; the use of carbon dioxide for gas production, therefore, cannot be of much value.

"Siemens uses waste products of combustion containing carbon dioxide, and, therefore, introduces about 90 cbm. nitrogen with 22.3 cbm. carbon dioxide (see J., 1890–190). The resulting gas would then have the following composition:

	Cbm.	P. r Cent.
Carbon monoxide	133.8	34.2
Nitrogen	257.8	65.8
	391.6	100.0

"In fact this composition of the gas could not be attained without greatly preheating the same, because it requires about 27,000 heat units to raise the temperature of the 90 cbm. nitrogen to the producer temperature, 1,000°, so that more than one-half of the available heat would be used for this purpose. Fifty-four kg. carbon could, therefore, produce:

	Cbm.	Per Cent.
Carbon monoxide	111.5	34.4
Nitrogen	212.8	65.6
	324.3	100.0

which have a thermal value of 340,000 heat units, or 78 per cent. efficiency. Therefore, considering the efficiency of the process from a standpoint of the total heat development of the fuel, the use of water vapor is much more desirable than that of products of combustion containing carbon dioxide. Calling the gas under the latter (Siemens) discussion 3a, we have the following tabular comparison of the various equations:

Equation Number.		2	3a	4	5
1 kg. C. produces gas in cbm		5.35	6.01	4.94	5.41
Composition of resulting gas in per cent.	CO_2	.. .	....	....	8.6
	CO	34.7	34.4	37.6	25.8
	H	....	...	9.4	17.2
	N	65.3	65.6	53.0	48.4
No. cbm. air required to burn 1 cbm. gas.		0.83	0.82	1.12	1.02
Products of combustion in cbm. of 1 cbm. of gas	CO_2	0.35	0.34	0.38	0.34
	H_2O	...	....	0.09	0.17
	N	1.31	1.31	1.41	1.29
Total		1.66	1.65	1.88	1.80
Thermal value of 1 cbm. gas (water vapor from 20°)		1,058.	1,049.	1,389.	1,231
Available heat units of the next above thermal value, if the products of combustion escape at 1,000°		477.	471.	731.	601.
Do. for 1 kg. carbon		2,552.	2,831.	3,611.	3,251.

"From the above table it appears that the use of products of combustion, as per 3a, is not as efficient as the application of water vapor. An inspection of equation No. 4 shows this to be the one we should strive to produce. If, on the other hand, we could arrange to preheat the mixture of primary air up to, say, 500° to 550°, we could utilize the equations as follows, on account of having more available heat:

3 No. 2 = 3C + 3O = 3CO.
2 No. 4 = 2C + 2H_2O = 2CO + 2H_2, or combined,

5C + 3O + 2H_2O = 5CO + 2H_2.

'Again,

3 No. 2 = 3C −|− 3O = 3CO.
2 No. 5 = 2C −|− 4H_2O = 2CO_2 −|− 4H_2, or combined,

5C −|− 3O −|− 4H_2O = 2CO_2 −|− 3CO + 4H_2.

"From this we see that 60 kilogram of carbon combine with 159 cbm. air and 36 and 72 kg. water vapor respectively (equations 4 and 5), and result in:

	Eq. 4. Cbm.	Eq. 5. Cbm.
CO_2	....	44.6
CO	111.5	66.9
H	44.6	89.2
N	125.8	125.8
Total	281.9	326.5

Total thermal value (water vapor from 20°)		455,200 cal.	434,400 cal.
Efficiency		94 per cent.	90 per cent.
1 kg. C. results in gas		4.7 cbm.	5.44 cbm.
Composition of gases in per cent.	CO_2	....	13.7
	CO	39.5	20.5
	H	15.8	27.3
	N	44.7	38.5
Thermal value of 1 cub. meter gas		1,612 cal.	1,330 cal.

"This tabulation shows that the preheating of the mixture of water vapor and air has a very favorable influence. In gas benches where high heats are required this preheating would probably be made to go as high as 1,000°. The entire heat of reaction 2 could then be changed into chemical work, and for one reaction No. 2 we could add one reaction No. 4 (No. 5 is out of the question at this temperature), and for 4 No. 2, almost 3 No. 3 could be applied. To obtain pure carbon dioxide is apparently out of the question, so that only products of combustion (with 20 per cent. of CO_2) can be considered.

4 No. 2 = 4 C −|− 4O = 4CO.
3 No. 3 = 3C −|− 3CO_2 = 6CO, or combined,

7C −|− 4O −|− 3CO_2 = 10CO.

"Again,

1 No. 2 = C −|− O = CO.
1 No. 4 = C −|− H_2O = CO −|− H_2, or combined,

2C −|− O −|− H_2O = 2CO −|− H_2.

"The results are as tabulated:

Equation No.		3a.	4.
Amounts of resulting gas	CO_2	....	....
	CO	223.0 cbm.	44.6 cbm.
	H	....	22.3 cbm.
	N	435.4 cbm.	42.0 cbm.
Total		658 4 cbm.	108.9 cbm.
1 kg. C. produces gas		7.82 cbm.	4.54 cbm.
Composition of gases in per cent.	CO_2	....	....
	CO	33.9	40.9
	H	.....	20.5
	N	66.1	38.6
Thermal value of 1 cub. meter gas		1,034 cal.	1,776 cal.

"If the gas and air for combustion are brought into the furnace at the same temperature as that at which the products of combustion leave the furnace, it is evident the entire heat of the gasified coal is used up in the furnace, excluding the losses through the walls. Practically this is not possible, and the gases must always leave the producer much hotter than they can enter it in this particular method. If gas and air enter at 1,000° and the products of combustion leave at 1,400° we have the following:

Equation No.		3a.	4.
1 cbm. gas results in cbm. of products of combustion	CO_2	0.34	0.41
	H_2O	....	0.20
	N	1.30	1.54
		1.64	2.15
Thermal value of 1 cbm. of gas		1,034 cal.	1,776 cal.
Of this there is available		772 "	1,432 "

"In order to introduce equal quantities of heat into the furnace, it is necessary to use twice as much gas produced from carbon dioxide (3a) as that from water vapor. Therefore, it would be necessary to use apparatus about twice as large, which would result in correspondingly greater heat losses by radiation so that the introduction of gas produced by products of combustion is still more undesirable than shown above. In the new Siemens furnace, a portion of the products of combustion is conducted under the grates by means of a steam jet. It has already been proved that the claims under this invention were not correct (see "J.," 1890–91), and the foregoing figures show that the introduction of products of combustion, even at a temperature as high as 1,000° is very uneconomical. The only question remaining, therefore, is whether it is economical to introduce still hotter gases. The reaction C −|− CO_2 = 2 CO, requires 39,000 heat units; 22.3 cbm. carbon dioxide are mixed with approximately 90 cbm. nitrogen, or there are approximately 112 cubic meters of products of combustion.

"If we assume the specific heat of these gases over 1,000, even as high as 0.4, the gases would have to be conducted to the generator some 900° hotter than is requisite for the reaction, or at a temperature of about 1,900°, which cannot be accomplished readily in practice. Siemens introduces steam at the same time, which again necessitates considerable quantities of heat for raising its temperature and decom-

posing it. Without introducing air at the same time this proposition is impossible. The reaction:

$$2C + CO_2 + H_2O = 3CO + H_2$$

requires 68,000 heat units. If the products of combustion were introduced into the generator at 1,400° they carry with them 17,900 heat units, whereas the heating of the vapor up to 1,000° requires 8,800 heat units. There would then remain 59,000 heat units to be supplied by the reaction

$$C + O = CO = 29,000 \text{ heat units.}$$

"Under the most favorable circumstances the air could be introduced at a temperature of about 1,200°, and the reaction then would be:

$$4C + CO_2 + H_2O + O_2 = 5CO + H_2.$$

"Therefore, 46 kg. carbon, 112 cbm. of products of combustion, 18 kg. water vapor, and 106 cbm. air, would result in the following gas:

CO.....	111.5 cbm.	36.3 per cent.
H.....	22.4 "	7.3 "
N.....	173.1 "	56.4 "
	307.0 "	100.0 "

Thermal value of 1 cubic meter gas = 1,295 cal.

"It appears, therefore, as though the gas obtained even under such favorable conditions is not as economical or efficient a process as that obtained by the use of water vapor; in fact, owing to the inevitacle losses, the results will be much poorer. The introduction of products of combustion into a gas producer is, therefore, in every respect an unfavorable proposition, and the circulation of the great quantities of nitrogen always results in large heat losses. If the process really results in a saving of 50 per cent. of fuel, as claimed, it merely goes to prove that the previous operation under the old method was just that much poorer than it should have been."

According to Dr. Fischer's calculations as above, as extracted from his "Jahres-Bericht" for 1903, it would appear that there is theoretically every reason to believe that the process of returning waste gases back under the fire is not as economical as the use water vapor. I searched through Jüptner's work in the hope of finding some reference or calculations relating to this subject, but was unable to see anything. In the further hope of securing some facts or working data on this method as applied abroad, I have written to F. Siemens & Co., Dresden, Germany, for their actual experience along this line in the glass as well as in the gas industry. I also have a promise from Dr. H. Bunte, of Karlsruhe, Germany, to recite his ideas and experiences. If these two answers arrive in time they will be found among the addenda at the end of the paper, otherwise they will have to be reserved for future use.

Efforts Made in the United States to Accomplish Greater Fuel Economy and for Clinker Prevention.—My discussion so far has been entirely on the work done abroad. Upon investigating the inventions and research work undertaken in this country I have been unable to find anything, except certain patents and applications of same in certain plants. The patents that have come to my knowledge are 829,105, 844,504 and 848,729. It is not my intention to go into the details of these patents, as anyone desirous of studying them can readily obtain copies from the U. S. Patent Office, Washington, D. C.

I have, however, endeavored to secure working results from some of the installations already put in, and to ascertain from these plants the commercial value of the method. I regret very much that St. Louis has no recuperative benches operating on coal gas, or I should certainly have made thorough tests to be presented in this paper. In the next section of this paper you will find the actual reports of operation of a large number of companies, in reply to a circular list of 100 questions that I sent out. Among these will be found the answers of one company using the return flue gas method, as patented in this country. I have also the unofficial report of one other company, from one of their chemists no longer in their employ, in the form of a letter, which I will quote later on. Referring first to the one company whose answers will be found later on, under No. 34, we find as follows:

This company operates benches of 6's with average fire depths of 5 feet. Now what criticisms can be applied to their answers as far as the return flue gas method is concerned?

First, they have but one station meter, and the coal gas and water gas are mixed before passing through this meter. This at once makes all their reported results very doubtful. I would not be surprised if these results were wrong as much as 5 per cent., or possibly even as much as 8 or 10 per cent., because they certainly estimate the results of one kind of operation (say coal gas) and get the water gas results by subtracting from the total.

Second, they fail to give the size, kind of drum, and maximum rate per hour of sending gas through the station meter. Without absolute knowledge at hand I very much suspect their station meter is greatly overloaded at certain hours of the day at least, a condition conducive to great non-accuracy. Furthermore, not giving their ideas as to the accuracy of the station meter during the past 12 months, would lead me to strongly suspect that perhaps the drum was badly rusted out, possibly full of holes, etc. This may not be true, but it throws doubts on the results. Note also that 10 of their benches were refilled completely as far back as 1900. Otherwise the answers are clear and not subject to criticism. The bench fuel reported by No. 34 is 246 pounds coke per ton coal carbonized, obtained largely, I assume, by the use of the return flue gas method. As contrasted to this, observe the answer of company No. 7, which reports 235 pounds coke as bench fuel per ton coal carbonized. Observe also the difference in the coal itself and the thermal value of the coke. Company No. 7 does not use return flue gas scheme, but separately meters its coal gas, and there is no criticism to make on its operation.

I was unable to secure any official data as to the return flue gas installation at St. Paul, but have a letter from Mr. R. M. Redding, who was formerly chemist of that Company, dated August 10, 1907, which I herewith reproduce in full.

"New Orleans, La., Aug. 10th, 1907.

Mr. W. A. Baehr, Engineer, Laclede Gas Light Co., St. Louis, Mo.:

Dear Sir: Mr. Miller has handed me your circular letter regarding the manufacture of coal gas, and suggested that I answer such questions as came under my personal observation while connected with the St. Paul Gas Light Company. Without doubt, you will receive from Mr. Doty very complete replies, so I will confine myself to those questions dealing with the use of economizers.

"The fuel economizer of the Improvement Equipment Company was placed in the St. Paul plant a year ago last spring, and was pu in service shortly after my going with the Company in June. During the 8 months of my service there the economizers were largely under my control. The fuel used was gas house coke made from Pittsburgh coal and had a calorific value of about 13,300. In the working of the economizer the fuel gases are drawn from a point near the entrance into the stack by means of an air injector and driven under the grate, from which point they ascend through the grate bars, which are thereby cooled, and on through the bed of fire where the CO_2 is reduced to CO. The economizer is so built that each bench may be controlled independently; also, each bench has 2 injectors (one on each side) which may be regulated independently. The Improvement Equipment Company claim that satisfactory results will be secured by the return of 25 per cent. of the flue gases under the the grate. This, however, is not my experience with the remodeled benches in St. Paul (Bredel and Parker-Russell). With a flue gas showing 15-17 per cent. CO_2, I found it necessary to have not less than 8 per cent. CO_2 under the grate, which means that 50 per cent. of the flue gases had to be returned in order to keep the grate cool and free of clinker.

"I found that the proper balance necessary between the flue gases and secondary air required a rather delicate adjustment of pressure, nozzles on the injectors, etc., and required some attention of such a nature that one not familiar with the scientific principle upon which the economizer works. would be at a loss to correct the trouble.

"Under intelligent supervision the economizer is of value. Heats may be brought up in about half the time required for benches fired in the ordinary way. The work dependent on the fireman is lessened to a marked degree, in that little or no clinkering is required, since the fuel burns to a clean ash with only an occasional small clinker. One man can handle about twice as many benches so operated as against those fired in the ordinary way.

In conjunction with a representative of the Improvement Equipment Company, Mr. Geo. Steinwedell and myself made comparative tests of benches equipped with the economizer and those fired in the ordinary way. The actual figures I have not at hand, but the test showed a saving in favor of benches equipped with the economizer in point of fuel saved, labor required to maintained fires, etc.

Respectfully yours, R. M. Redding, Chemist."

A paper entitled "Bench Fuel Economies," by Mr. F. M. Richards, of Madison, Wis., read before the Wisconsin Gas Association in 1907 (see American Gas Light Journal, May 27, 1907, p. 886). treats of the return flue gas method and the results accomplished by it. Un-

fortunately Mr. Richards does not tell us of all the factors entering into such a result. For instance, does he separately meter his coal gas? is the meter correct? how does he know that, etc.? It is very hard to accept results as worth anything unless all factors which may influence such results are considered, and covered by the paper. In the discussion of Mr. Richard's paper the matter of the power required to introduce the return flue gases under the grates was brought into question. In regard to this point I can quote from a letter received from Mr. E. Y. Sayer, General Manager of The Improved Equipment Company, 60 Wall street, New York city, under date of September 3, 1907, as follows:

"We have a small positive pressure blower having a capacity of 5 benches at Mattoon. This blower is direct connected to a vertical engine having cylinder dimensions of 4¼ inches by 5 inches. They have a small 25-horse power boiler which furnishes steam for the entire plant, operating the exhauster and blower. Nothing but breeze is used in the boiler, and the boiler fuel amounts to 600 pounds of breeze per 24 hours. The steam pressure will vary from 60 to 80 pounds. The engine is a small, slide valve engine, and whereas we have never indicated it would imagine that it is developing something slightly over 1-horse power. It is operated at about 150 revolutions per minute, and certainly the mean effective pressure is not over 30 pounds per square inch. The air is delivered at 25-ounce pressure and this blower outfit is guaranteed to develop 5 pounds air pressure with 80 pounds steam. With a mean effective pressure of 30 pounds you will see the engine is developing about 1.02-horse power.

"I am going somewhat into detail about the power required to operate one of our air injectors, for the reason that so much discussion has occurred on this point, and apparently it is very much misunderstood by everyone. We have in Denver 36 benches operating with the economizer. Last year we installed 10 new benches of 6's there that are every day carbonizing 7.2 tons of coal. The air is furnished to the injector at a pressure of from 25 to 30 ounces per square inch, which represents, allowing an efficiency of blower of 66.6 per cent., 0.249-horse power per bench. Estimating 50 pounds steam per hour per horse power developed at the engine and an evaporation of 5 pounds of steam per pound of boiler fuel, it requires 60 pounds of boiler fuel per bench per day to operate the economizer. This fuel is mostly breeze and cheap coal, which have a monetary value of about one-half less than that of coke. Therefore, calculated on a value basis, it requires about 30 pounds of coke to operate the economizer per bench per day of 24 hours. These are actual figures, and to substantiate their accuracy I am submitting our calculation.

"If you will refer to a copy of 'Mechanical Draft,' published by B. F. Sturtevant & Co., in whose catalogue No. 98, on page 148, table No. 91, you will find that the actual power represented by a jet of air under 15 ounces pressure per square inch, the nozzle having an effective area of 1 square inch, is 0.5518-horse power. By doubling this pressure, namely, 30 ounces per square inch, it represents an actual horse power of 1.1036. We have benches operating in Denver where the nozzle is reduced to its smallest dimension, namely, $\frac{7}{16}$ inch. Therefore the amount of air issuing from one of these nozzles would represent 0.166 of a horse power. The positive pressure blower companies guarantee 85 per cent. efficiency for their blowers, but for safety calculate that due to inefficiency of the blower and loss in pipe the actual power represented by the air at the nozzle would be two-thirds, or 66 per cent. efficiency. This would indicate a continuous horse power of .249. Allowing 5 pounds evaporation per pound of boiler fuel and 50 pounds of steam per horse power hour of engine, this would represent 60 pounds of boiler fuel per bench per day. The entire calculation is as follows:

"15 ounces per square inch pressure (nozzle 1 square inch) = .5518-horse power.

"$0.5518 \times 2 = 1.1036$.

"Diameter $\frac{7}{16}$ inch = 0.15033 square inches.

"$1.1036 \times 0.15033 = 0.166$.

"Consider $0.166 = 2/3$ power $\therefore 3/3 = 0.249$-horse power.

"Allowing 5 pounds evaporation and 50 pounds steam per horse power hour,

$$\frac{1/4 \times 50 \times 24}{5} = 60 \text{ pounds of fuel.}$$

"As a matter of fact, at one of our plants where we have an electrically driven blower, and there is in circuit with the motor a voltmeter and ammeter, these results are verified. We are going into a good deal of detail on this subject as it is important, and we would like you to be thoroughly familiar with this feature of the economizer. At Mattoon, where they used to have direct fired benches, and their bench fuel was something over 500 pounds, we have cut the bench fuel at that plant in two, and when they get to using hot coke in their furnaces and running both benches at their normal capacity, their bench fuel will probably drop to 210 pounds. We are extremely anxious for you to see one of our types of benches, and, if possible, would like to have you make arrangements to run a test on some one of our plants, possibly Mattoon, as it would be the most convenient to St. Louis.

"After seeing the manner in which we handle the hot flue gases and the temperature at which they are introduced beneath the grate bars, you will probably understand where we get the high efficiencies that we are obtaining.

"In some of the trade journals the blower required to operate the economizer is referred to as a compressor. In no instance do we exceed 30 oz. of air per square inch, and some of our plants are running on 15 oz. per square inch. You will, therefore, see that the word compressor is not applicable. It is impossible to describe the difference in operation of one of our benches equipped with the economizer and the ordinary type of bench. The installation partakes of a forced draft, which draft is under control and maintained at absolutely uniform pressure, as we have an automatic pressure regulator keeping the pressure of air constant regardless of the amount of air required. The opening of the injector is controlled by a hand wheel and we have any amount of heat at our control that is necessary. The heats on the retorts are absolutely uniform and there are absolutely no clinkers whatever in our furnaces. In furnaces we have operated for four years, as far as can be ascertained from inspection. The linings are in as good a condition as the day they were started up.

"We have only made one installation which is not satisfactory to us; namely, St. Paul. The reason for this is that we took some old benches that had been running for years, and by means of outside injectors endeavored to equip them with the economizer. Just what results have been obtained at St. Paul we do not know. However, we are informed that it has stopped the clinkers and makes some considerable saving in bench fuel. Since then we have entirely abandoned trying to equip old benches with the economizer. For this reason the St. Paul plant may not be entirely satisfactory. All others of our plants seem to be giving very satisfactory results."

The foregoing comprises about all available information on the subject of the return flue gas method of bench operation in the United States that I was able to secure to the date of this writing. I may add that I have a copy of the Improved Equipment Company's instructions for operating its so-called economizer, but this falls within the realms of trade literature, and should readily be obtainable by any one writing for a copy. I will, therefore, omit it from this paper.

Conclusions as to Value of Return Flue Gas Method.—It is difficult at present to speak with absolute certainty in regard to the value of this method. From a standpoint of the purely theoretical considerations of the thermo-chemistry of the case, it would appear, from Dr. Fischer's figures hereinbefore presented, that the method is not economical as compared to the method of introducing water vapor properly preheated. The statements in Dr. Fischer's book are so positive that I would hesitate very much to accept any contrary views at present. They have evidently worked on various return flue gas installations abroad for a number of years.

At the same time the history along this line in this country is altogether insufficient to allow us to base conclusions upon it. The advocates of the return flue gas method claim its superiority over the introduction of water, by stating that large quantities of water must be used to keep down the formation of clinker, and because of the high specific heat of water vapor they say a great deal of heat escapes from the stacks. It appears to me, however, that we are not using water vapor properly, and when we learn to do that we will be able to accomplish much better results than heretofore, and very likely better than can be obtained by the return flue gas method.

I would suggest that benches be so designed that both the primary and secondary air be preheated as well as the water vapor, and that the primary air be so arranged that there will be an absolutely homogeneous mixture of it with steam. In that way excessive quantities of water will not be required. I understand one large plant in this country introduces steam under the fire by capping up the end of the steam pipe and drilling a small hole through the cap of the right size to introduce the proper quantity of steam under the average boiler pressure maintained at that plant. This required some experimenting,

but now the stokers and other men cannot alter the quantity of water vapor introduced, and it looks like a very good and simple solution of the problem to me.

I wish to call attention to an additional factor that appears to have some influence on the choice between water vapor and return flue gas. On page 145, "Beilage zum Chemiker-Kalender," 1902, we find the heat of formation of combination of hydrogen and oxygen at various temperatures as follows;

		Gaseous.	Liquid.
Water — H_2 + O = H_2O at	0° C.	-|- 58.3	-|- 69.0
" — " = " "	2,000° C.	-|- 50.6	
" — " = " "	4,000° C.	-|- 37.1	

On page 151 of the same book we also have the heat of formation of combination of carbon monoxide and oxygen as follows:

CO_2 — CO -|- O = CO_2 at	15° C.	-|- 68.3
" — " = " "	3,000° C.	-|- 37.0
" — " = " "	4,500° C.	-|- 28.0

From these exothermic reactions we can draw from the foregoing that at increasing temperatures the heat of formation of H_2O falls off less rapidly than that of CO_2 from CO. If, therefore, Dr. Fischer had used the proper heats of formation at the various temperatures, it would appear that the difference in favor of the use of water vapor would have been still greater than shown by his figures.

One more point is worthy of attention. If Table No. 6, page 13, 1906 Edition, Emilio Damour's "Industrial Furnaces and Methods of Control" is correct, it would appear, by taking molecular equivalents, that the loss of heat of water vapor escaping from the stack from 1,400° C. down to 0° C. is less than the loss of heat of CO_2 with its accompanying nitrogen from 1,400° C. down to 1,000° C. Therefore, from a standpoint of the efficiency of heat transmission from carbon to gaseous fuel. the heat carried off from the combustion chamber is less with water vapor than with CO_2 and its accompanying nitrogen.

When the advocates of the return flue gas method lay so much stress upon the high specific heat of water vapor as compared to CO_2, or nitrogen *per unit of weight*, they evidently forget that the specific heats of these substances, when compared on a basis of molecular equivalents, are practically the same, with that of CO_2 somewhat higher. For instance, see Table 7, Damour's book, page 13:

Molecular weight of CO_2 = 44; molecular weight of H_2O = 18.

From the Table at 1,000° C. the thermal capacities are as follows:

H_2O — 609 per kg.
CO_2 — 277 per kg.

Thermal capacity of

44 kg. CO_2 = 44 × 277 = 12,188
18 kg. H_2O = 18 × 609 = 10,962

From Dr. Fischer's equations 3 and 4, which are

C -|- CO_2 = 2CO = — 39,000 cal.
C -|- H_2O = CO -|- H_2 = — 39,400 cal.

we see that molecular equivalents of CO_2 and H_2O are used per atom of carbon. From this the loss of heat of water vapor escaping from the stack (even with the high specific heat of water vapor) is not serious in comparison with similar losses due to CO_2 and nitrogen.

The burden of proof is apparently up to the advocates of the return flue gas method. If they can apply their proposition to a plant which is generally accepted as being operated competently, and where the gas is separately metered, where the coal carbonized is properly weighed, and where in general all the factors entering into the results are properly taken care of, then we can begin to secure an idea of what they can accomplish. On the other hand I am perfectly satisfied that the use of water vapor or steam has by no means found its ultimate development, and there is no question that the bulk of plants would be considerably improved in results if they were subjected to strict examination and overhauling; that is, I believe present results, even with present apparatus, are far below what they should be.

One other important point is worthy of notice. It seems the prevailing opinion that primary air should not be preheated. Such an assertion looks utterly illogical to me—a deliberate waste of heat. No matter what concurrent arguments may be applied, some correct method of utilizing preheated primary air should be found.

It is right here that the advocates of the return flue gas method, unconsciously perhaps, score a point over the ordinary bench. They introduce their primary air in mixture with hot waste gases, thus really preheating the primary air by actual contact with the heating medium and under conditions of the highest efficiency, the same as in a steam jet condenser where the highest heat transmission efficiency from steam to water is reached by actual contact. I would not be at all surprised if a considerable portion of the economy claimed results from this preheating of primary air. There can be really no good reason why a bench cannot be designed to use water vapor properly, and to preheat both primary and secondary air, which, if Dr. Fischer is right, would result in a more efficient bench than the other type. In fact I believe such benches have been in use a long time in Germany and elsewhere. To be sure, clinker formation is certainly prevented by the return flue gas; but if this is accomplished at the expense of fuel economy, why do it in that way? Then, too, the question of saving in repairs is in that state where no data are available whatever. I am inclined to believe that the facts presented so far would, to say the least, make me desire much better proof than is heretofore presented, before I would concede the superiority of the return flue gas method of operating recuperative benches, over a proper method with water vapor.

We can at present readily see, however. that this agitation in regard to bench economy will surely result in good. The electric light resurrected the gas business from 99.44 per cent. of stagnation, and while the percentage may not be so great, let us hope the flue gas method will stimulate us all to much greater efforts (and consequently benefits) in our recuperative bench design and operation.

Results at Various Plants as Reported in Answer to the 100 *Questions.*—One of our most prominent young gas managers made the following remark to me recently:

"I believe that we have got to get back, a little at least, to the old idea that there is a great saving to be made in the retort house. Some of our enthusiastic fellow gas men have been talking other things so long and so loud that their retort houses won't bear inspection."

A similar idea, coupled with the desire for actual facts, was one of the factors which led to my sending out a list of 100 questions relating to retort house practice. Altogether we sent out about 750 lists, and out of these have to present herewith the answers from about 40 companies. It seems a little odd that it should be so hard to get people to send in answers which are intended to result in good for all. At first I endeavored to combine the answers into one general table, but this now appears unsatisfactory. There is a great deal of valuable information in each set of answers, and I have, therefore, decided to insert them in full. In the following pages you will find:

First, the list of 100 questions.

Second, the complete answers of all companies reporting arranged in groups, according to types of benches, the companies being numbered, not named.

Third, a *resumé* of the important results of operation, being in general the averages of certain sets of answers for each group of reporting companies.

List of 100 Questions.

1. What number and type of recuperative benches have you in your plant?
2. Who built these benches?
3. What is the average number of these benches you have operated in the last 12 months?
4. Give the dimensions and number of retorts per bench?
5. When were the benches you operated during the past 12 months completely refilled, and what was their average physical condition during this time?
6. When were the benches you operated during the past 12 months refilled above recuperators, and what was their average physical condition during this time?
7. Give grate area of the furnace?
8. State depth in feet and inches from top of top recuperator to bottom of bottom recuperator?
9. Give vertical distance from grate bars in furnace to top of chimneys for escape of products of combustion?
10. State average depth of fire in furnaces, as near as you can determine it?
11. What kind of gas coal did you use during past 12 months?
12. Give average yield of gas per pound of coal carbonized during past 12 months, corrected to 60° F., and state if you also correct to 30″ bar.?
13. Do you separately meter your coal gas?
14. Is your coal gas mixed with water gas before it is metered?
15. Have you no station meter?
16. If you have separate coal gas station meter, state its size, kind of drum and maximum rate per hour at which you passed coal gas through it during last 12 months?

17. When was such coal gas station meter last tested?

18. What is your idea of the average accuracy of this coal gas station meter during last 12 months? Why?

19. What was the average amount of coal carbonized per active retort in last 12 months per 24 hours?

20. What was average candle power of your coal gas during last 12 months, corrected to 60° F. and 30″ bar?

21. What was average net B.T.U. of your coal gas during past 12 months?

22. What was percentage of active retorts to total number of retorts under fire during past 12 months; in other words, what percentage of idle retorts could we figure on in your plant, owing to scurfing, etc.?

23. What kind of bench fuel did you use during past 12 months?

24. What was its average calorific value?

25. What was the average proximate analysis of this bench fuel as nearly as you can give it?

26. How many pounds of this bench fuel did you use on the average during the past 12 months per ton coal carbonized? (Figure ton as 2,000 pounds.) How do you obtain this figure? Is bench fuel actually weighed? How?

27. How many pounds of water and steam per 100 pounds bench fuel did you run into ashpan and under fire during past 12 months? If you do not know, please make an hour's test and insert result from that.

28. Did you have any excessive clinkering to do? Explain.

29. Are you returning any portion of the waste flue gases under the fire?

30. Where are these waste gases taken off?

31. What was their average temperature at this point during past 12 months?

32. What was their average chemical composition during this time?

33. What percentage by weight of total waste gases did you return under fire?

34. What percentage by weight of total air and gases mixed going under the fire was this waste gas thus returned?

35. What average percentage by weight of CO_2 was there under fire during last 12 months?

36. Did the use of return flue gases enable you to dispense with water or steam under the fire, and thus secure as little or less trouble with clinkers? Explain.

37. What saving in bench fuel, per ton coal carbonized, resulted from the use of such a scheme?

38. What labor saving resulted?

39. Did your results vary any from what they were prior to introduction of such a system? Explain fully.

40. What differences did you observe in the operation of the benches thereafter?

41. What repairs to the bench were caused by introducing those waste gases under the fires, if any?

42. How many pounds of water or steam did you save per 100 pounds of bench fuel while returning these waste gases under the fire?

43. Was it necessary to use any water or steam under the fire at all during the operation with these waste gases?

44. Was the temperature of the stack gases raised or lowered when using these waste gases?

45. How do you deliver these waste gases under the fire?

46. How does your retort house foreman regulate the amount of these waste gases?

47. How does your retort house foreman know when he has reached the proper amount of waste gases he desired to introduce under the fire?

48. Is the regulating of the waste gases accomplished on each individual bench, or so arranged that it handles a complete stack?

49. Have you any determined method of obtaining the proper amount of waste gases required? If so, explain.

50. Is the regulation of these waste gases very difficult or simple? Does it have to be watched very carefully?

51. In figuring a saving resulting from the use of a portion of the waste gases under the fire, did you take careful consideration of all the factors entering into such a result, such as yield of gas per pound coal carbonized, etc.?

52. From your experience, do you believe there is any real value in using the return flue gas scheme? Explain. Or would you stick to the older method of introducing water and steam under the fire? Why?

53. In ordinary bench operation (not considering any return flue gas scheme) how do you regulate the proper amounts of primary and secondary air?

54. Do you think of any satisfactory way whereby an average retort house foreman could regulate his bench heats and air openings except by chemical analysis of the waste gases? Explain.

55. How many days, after an entire new stack of benches is completed, do you consider it necessary to heat it gently before bringing it up to full heat for regular operation?

56. How many days after a bench is refilled from the ashpan up, do you consider it necessary to heat it gently before bringing it up to full heat for regular operation?

57. How often do you think it wise to scurf retorts? State answer in days.

58. How many hours would you allow for scurfing a retort, and how would you do it?

59. Do you think a bench should ever be let down except for repairs, if you can so arrange your operation to make this possible?

60. How would you clean flues so as to injure a bench as little as possible?

61. How would you clinker and take out ashes so as to injure a bench as little as possible?

62. How would you put in coke as bench fuel so as to insure best results and injure a bench as little as possible?

63. How would you put in coal as bench fuel so as to insure best results and injure a bench as little as possible.

64. Would you use water, steam or flue gases under the fire? Why?

65. How would you draw and charge your retorts so as to injure them as little as possible?

66. Would you quench your coke by throwing water on it as it lies on floor or in conveyors or chutes in front of bench, taking into account the injurious action on the bench of having water thrown on the hot brick?

67. Would you keep dust off top of stacks, tar off the mouthpieces, etc., in order to prolong the life of the benches?

68. Would you allow your chemist to regulate your heats in preference to any other method?

69. How often do you fire your furnaces?

70. Have you any method of preventing the cooling of the bench when clinkering or firing?

71. If you have any such method, does it work automatically? Explain.

72. Do you operate your bench with a high heat or medium? Consider above 1,500° C. high heat in combustion chamber?

73. Give degree of heat, if possible.

74. Is it advantageous or disadvantageous to operate your bench under such a heat?

75. State these advantages and disadvantages?

76. Have you any flame coming out of the stack?

77. When this is the case what do you do to remedy it?

78. Have you much trouble with stopped standpipes?

79. To what do you attribute this trouble?

80. Would you advocate using a separate producer for firing a stack of benches if your retort house is large enough?

81. What would be your reason for advocating the above?

82. Why would you advise against it?

83. How often do you clinker?

84. When do you clinker or fill your furnaces? Just before the draw or after the draw?

85. Do you charge your retorts by hand or by machinery?

86. How long are your lids off of the mouthpieces? (Take the time from the beginning of the draw until the end of the charge.)

87. How do you control the primary air you admit? Explain.

88. Whom do you allow to regulate the primary and secondary air? The retort house foreman or any of the stokers?

89. Do you preheat your secondary air? How many degrees C.?

90. How do you introduce your water or steam into the ashpan?

91. Do you keep a record of the performance of each bench?

92. Why?

93. What kind of refractory material have you found the best for bench construction?

94. If you have inclines or verticals, please state briefly how you regulate your heats, clinkering and clinker prevention, and whether you find any difference in these respects as against ordinary retort house with horizontals?

95. Do you introduce any air into the coal gas prior to the station meter?

96. When do you introduce this air?

97. What per cent. of the total coal gas made, corrected to 60° F., is such air?

98. Do you preheat such air?
99. If so, to what temperature?
100. Why do you preheat it?

RÉSUMÉ.

Question No.	So-called Full-Depth 9's.	So-called Full-Depth 8's.	So-called Full-Depth 6's.	So-called ¾-Depth 6's.	Socalled ½-Depth 6's
12	4.80	4.88	4.85	5 — (not corr.)	4.81
19	2,036	4,316 throughs	4,200 throughs	1,500	1,762
20	15.03	15.59	15.8	17.	16.5
21	602	622 gross	....	...	....
22	94.5	95.34	96.6	97.5	88.66
23	Coke 10	3	4	2	11
	Coal 1	1	1	1	1
	Mixed 1	1	1	....	4
24	....	13,500 coke	...	....	....
25	Coke 281.5	281.4	288.	....	380.
	Coal 441.	231.	364.	....	372.5
	Mixed 274.8	274.8	274.8	....	348.
55	31	44	32	19	17
56	13.6	25	16	12	8.5
57	41	37	62	7	44
69	4	5	4	6	2.6
80	Yes	....	10	....	.. .
	No	....	6	....	....
83	41 hrs.	40 hrs.	78 hrs.	64 hrs.	65 hrs.

Simple Rules to Govern the Care and Operation of Recuperative Benches.

In this portion of my paper I will endeavor to formulate a set of rules so simple and concise that any retort house foreman can readily understand and follow them. Time required to bring various kinds of recuperative bench installations to operating heat after being shut down, or when new.

Entire New Stack of Benches:

Time required for drying, 15 to 20 days, depending on size, atmospheric and general conditions; time required after drying to bring benches to operating heat, 5 to 10 days.

Entire Old Stack of Benches, after Being Shut Dawn for Some Time:

Time required for drying, 5 to 10 days; time required after drying to bring benches to operating heat, 3 to 5 days.

Single New Benches in Old Arches:

Time required for drying, 10 to 15 days; time required after drying to bring benches to operating heat, 3 to 5 days.

Single Old Benches in Old Arches:

Time required for drying, 2 to 3 days; time required after drying to bring bench to operating heat, 2 to 5 days.

Precautions to be Observed before Starting Drying Out Fire:

Brick up mouthpieces, leaving hole about 2 inches square, to allow escape of moisture; close all dampers and sight-holes, except main flue damper; leave small air opening to underneath grate bars.

Drying Out Fire:

This may be started with wood kindling or hot coke. After starting, keep it up as a low (1 foot deep) coke fire, at dull heat at first, gradually increasing air opening day after day, until at end of drying out period, a low (say 2 feet deep) but fairly bright fire exists. Feed this fire at frequent intervals with small quantities of fuel, not varying the heat any more than can be helped.

General Instructions During Drying Out Period:

Watch expansion of brickwork very carefully, and carefully loosen buck stays and tie rods from time to time.

Keep damper in ashdoor open to burn up any carbon monoxide that may be formed, or if this is not above fire, the fuel feeding door can be left open.

Be sure to have main flue damper wide open, so that all gases, moisture, etc., can readily escape.

At the end of drying out period, the furnace portion of the bench should be at dull red heat.

To Bring Heat to Operating Conditions:

Clean and clinker fire thoroughly, then add coke until a fuel depth of about 2 to 2½ feet is secured.

Keep an ample amount of air going under the grate bars, so that fire will gradually brighten. Still keep feeding door open, but do not allow flames to come out of it. This can be regulated by main flue damper.

Keep dampers in ashdoor open.

Start water slowly dripping into ashpan.

See that primary air dampers are open.

Gradually increase depth of fire, until it is not less than about 3 feet deep just before firing.

When the combustion chamber begins to get hot the secondary air slides should be opened about ¼ of an inch each. Close fuel feeding door.

When certain that carbon monoxide gas is burning at the nostrils, and the furnace is at a bright heat, fill the producer with fuel, open secondary air slides to an ample amount, and increase the water running to the drippans and ashpan to full amount. Conduct the heating up process gradually, keeping up an excess of secondary air. If bench heats too rapidly, cut down primary air.

About 1 to 2 days before coming to full heat, remove brickwork from mouthpieces and charge retorts with small amount of slack coal, leaving caps on ascension pipes open at first, until ready to put hydraulic main into operation. The charge of coal in the retorts prior to regular charges, should be one large charge of slack coal, left in at least 12 hours, to fill cracks in retorts, etc.

Regulation of Furnace During Operation:

Have the works' superintendent or chemist set primary and secondary air slides after sufficient flue gas analyses have been made. After that, no one but the superintendent or chemist should be allowed to touch these slides. Since instructions for such analyses have been written and rewritten so often, I will not repeat them here.

Secure the most intimate mixture of water vapor and primary air that is possible with the construction under consideration. If steam is used under the fire, run in one or more pipes, cap up at ends, drill hole in each cap of proper size to admit correct amount of steam per hour with the average boiler pressure carried at plant. The superintendent or chemist to determine proper size of holes.

Keep fires clean, deep and level throughout.

When firing, keep firing door open minimum amount of time.

Same rule applies to clinkering or cleaning. It is advisable to have stack dampers to be closed during these periods.

The main flue damper should be open only so far that there is a very slight pressure in the setting. Any slight crack or opening around a sight-hole should, therefore, show a slight flame. Usually when clinkering it is advisable to use false bars.

General:

See that all cracks in brickwork are promptly patched, that sight-hole plugs fit tightly, that feeding doors into furnace (as well as all other doors) are tight, and do not permit air leakage into benches.

Keep top of stack clean and free from dust, tar, etc.

Clean out the recuperators frequently with scrapers, steam jet, or, still better, by compressed air. This should be done every 2 or 3 weeks. If leaks develop in recuperators, try to get them tight again by washing with a thin grouting.

Letting Down Settings or Benches:

This is virtually the reverse process from starting up, but is simpler. Put last charges into retorts about 1 hour before closing down. Have fire in producer not over 3 feet deep.

One hour after last charge, close primary and secondary air slides, lute all openings, shut off water supply, shut all dampers and allow bench or setting to cool down slowly. When cool, pull coke clean out of fire, and leave things clean and neat inside and outside of bench.

Retorts:

Keep well patched. Keep well scurfed. Scurf a little too often rather than not quite often enough. Scurfing is probably best accomplished by compressed air, but steam jets up the ascension pipes, or the ordinary D-tile will do where compressed air is not available.

Coal charges must be put in properly. Get coal well into back end of retort and have top practically uniform throughout. The shape of the top of the coal should be such as to best receive the radiated heat owing to the shape of top of retort. Have superintendent determine this point.

When charging or drawing, keep mouthpiece open as short time as possible. Keep mouthpiece bolts properly tightened, and keep eccentrics on self-sealing lids in good working order. Do not allow stokers to tighten eccentric levers by hammering with shovels, bars, etc. Do such work by hand.

Ascension and Bridge Pipes, Hydraulic Main:

These should be kept thoroughly and regularly clean. Have stokers push a gouge up ascension pipes after each draw. Thick tar should not be allowed to accumulate in hydraulic main. See to

this every day. Keep every hand-hole and cleaning-hole in working order, as well as the overflows.

Inspect every operating device about the bridge pipes and hydraulic main every day, and if ammoniacal liquor circulation is used, see that all jets are clear, pumps in working order, etc.

General:

Keep all air, steam, water and other pipes tight. Keep whatever machinery is used in good order and well oiled. Keep none but good, first-class tools for the use of the men, and keep properly repaired.

Last, by all means one of the most important instructions, is in regard to cleanliness. Keep your house clean, thoroughly in repair all the time, have floors swept regularly, provide receptacles for rubbish, proper lockers, toilet and wash facilities for the men; keep tar off all bench and ironwork, keep all dust off top of stacks, provide neat racks for tools, and endeavor to apply all the little useful devices for promoting ventilation you can.

Remember that cleanliness is the greatest simple factor tending to insure your success and the appreciation of superior officers.

Before concluding this paper, I wish to express my thanks to Mr. George S. Hessenbruch, of St. Louis, under whose direction a great deal of the reference and other matter used in the preparation of this paper was secured and arranged. I wish also to express my sincere appreciation to the officers of the companies sending in answers, and to numerous gentlemen, both in this country and abroad, who have kindly sent me information and data for use herein. References herewith appended.

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Discussion.

(In pursuance of the action taken by the Institute the following written discussions have been received:)

Mr. A. E. Forstall—Under the heading "Simple Rules to Govern the Care and Operation of Recuperative Benches," Mr. Baehr states that, before starting the drying out fire, the mouthpieces should be bricked up, leaving a whole 2 inches square to allow the escape of moisture, and that all dampers and sight holes, except the main flue damper, should be closed. My experience has never shown any necessity for bricking up the mouthpieces of the retorts, since, as long as the bench is being merely dried out, the mouthpieces can be left entirely open and as soon as the retorts begin to get hot loss of heat can be prevented by closing the mouthpiece lids. There is thus no reason for incurring the expense involved in bricking up the mouthpieces. Instead of closing all the dampers and sight holes, except the main flue damper, only the air slides and the main flue damper should be closed, all of the sight holes being left open. The reasons for doing this have been very fully explained in the answers to the "Practical Class," and the one treating of the operation of starting up a bench can be found in the Institute Proceedings, page 83, Vol. 1. The main flue dampers while closed at the start will, of course, have to be opened up later. In the rules for bringing the heat to operating conditions Mr. Baehr does not lay sufficient stress upon the necessity of always having the top of the fire bright so that any carbon monoxide which may escape from the fire will be ignited as soon as it comes in contact with air above the fuel bed. If this precaution is not taken there is danger of having an explosive mixture of carbon monoxide and air formed in the top of the furnace and the setting, while the top of the fire is cold, which mixture may be ignited with serious results when the fire brightens up. The only statement in regard to the regulation of the primary and secondary air slides which Mr. Baehr gives is that these slides should be set after sufficient flue gas analyses have been made. This rule is all right where there is either a chemist connected with the plant, or the superintendent has sufficient chemical knowledge to enable him to make the required analyses. These conditions are probably found in only a very small percentage of the gas works in the United States, and, therefore, it is well to have a rule for setting these slides which does not involve chemical analyses. Such a rule has been given by me several times and can be found in an answer to the "Practical Class," published in Vol. 1, Institute Proceedings, page 153. What seems to me another omission is the failure to give any rule for recognizing when the main flue dampers are properly set, except the statement that any slight crack or opening around the sight holes should show a slight flame. A rule which I think much better than this has been given in the same place as the rule for setting the air slides as referred to above. In regard to the rule given by Mr. Baehr that, when clinkering or cleaning, the firing door should be kept open the minimum amount of time, I think this rule should be made to read, the firing door shall not be kept open at all. With a good man in charge of the cleaning of the furnaces there is no necessity for opening the firing door during the cleaning of the fire, it being very easy to operate generator furnaces so that all the cleaning can be done through the lower clinkering door. In giving the rules for letting down settings nothing is said as to the necessity of opening up the bridge pipe covers and plugging the standpipes as soon as all the gas has been driven off the last charge of coal. It is necessary to do this in order to avoid any leakage of gas through the dip pipes and the standpipes into the retort. If such leakage occurs there is danger of an explosion which may do damage. In speaking of the care of the ascension, bridge pipes and hydraulic main, Mr. Baehr states that these should be kept thoroughly and regularly cleaned. It would be well, with reference to the ascension pipes especially, to state what thoroughly cleaned means, since different people have very different ideas as to thoroughness. Thoroughly cleaned means that a test ring only $\frac{1}{4}$ inch smaller in diameter than the interior of the pipe should pass freely down the pipe without meeting any obstructions.

Mr. Edward L. Rieha—It is very desirable at the present time that we adopt the word "recuperative" for gas benches of that construction, and not "regenerative." The latter term has been discussed before and should be abandoned. All examinations made of various literature dealing with the subject resolve themselves conclusively to the finding that only the word "recuperative" implies the correct interpretation. Gas benches should be determined as half, three-quarter and full-depth by the effective depth of fuel in the furnace. It is in all instances understood that the depth of the recuperator be calculated and built to suit the amount of available gases coming from the setting, respectively, the furnace. Their thermal capacities should be utilized to the fullest extent for preheating both the secondary and primary air; further, also, for evaporating the necessary steam. For such detailed figures I would refer to a paper by Geipert, which appeared in the *Journal für Gasbeleuchtung* for the year 1906, page 459. Waste gases passing into the last outlet flue should not exceed a temperature of 600 F. As stated before, primary air should be preheated with the water vapor. The idea that too high a temperature may result is entirely incorrect. This is regulated, and in practice no case is on record where the air introduced under the grates caused fusion of the pyrites or silicates in the fuel. The formation of clinkers calls for a higher heat usually not attained at this point in a furnace of correct construction. All reactions of furnace gases must be determined by proper control and should be as close to theoretical consideration as possible. The formations of CO and CO_2 in a producer are governed by temperature as well as distinct equilibrium, which allows the chemical reactions to take place. Regarding the return flue gas method, there is no doubt that the results obtained with this method

are better than experienced in the majority of ordinary retort benches The fuel consumption has been decreased to a large extent as its application and difficulties in clinkering are overcome. However, we must bear in mind that in no instance has there been made comparison with the benches using water vapor in the correct manner. In Germany ordinary recuperative benches are operating on 10 pounds of fuel per 100 pounds of coal carbonized. Such results were accomplished nearly 10 years ago, and evidently are much better at the present time. The new "Pintsch-Hermansen" benches, with "Rationelle" recuperators, are using on an average 9 pounds to 100 of coal carbonized. Authoritative reports can be obtained from various gas works to verify the statements. I refer herewith to ordinary horizontal, recuperative benches. It mainly depends upon the efficiency of secondary air recuperation, the proper homogeneous mixing of the water vapor with the primary air which are preheated to a certain degree and then introduced. The higher the furnace temperature the more water vapor can be introduced, and correspondingly higher will be the flame temperature of the resulting gases for combustion. There is a slight advantage in the introduction of CO_2 over that of steam. If, however, the vaporization of the steam is effected in the bench itself at the expense of its sensible heat (rather, that of the waste gases) the efficiency of water vapor is equal to that of carbon dioxide. Besides this the flue gas method requires exact control, and a large percentage of the waste gases must be returned for any furnace of ample dimensions. The latter usually carry only 18 per cent. of CO_2, and of this at least 50 per cent. must be brought under the grates to do good work. For large units it remains to be seen if this method will prove satisfactory at all when adopted. Purchasers of gas benches should lay down more specific and precise rules for making inquiries on their requirements. They should examine the value of the different constructions by inquiring into the efficiencies of the thermo-chemical processes involved.

(To be Continued.)

[Prepared for the JOURNAL.]

Loss of Power.

By "ENGINEER."

Gas engines, in fact all kinds of engines, are often compelled to labor under unnecessary difficulties, and possibly one of the chief factors relative to this point is that of lost power. Loss of power in the transmission of energy from the driving point to the delivery point in the power system is very common. The writer has been sketching a number of defective systems of power installation as seen in shops where various methods of propelling are used. In Fig. 1 is shown an example of the plan in which a certain combination of wheels and shafting was driven. A gas engine was installed in the right manner, at the side of the room, where a line of shafting was hung above. In addition to the balance wheel of the engine, a belt wheel, of 3 foot diameter, was put on and the driving belt (8-inch double) marked *A* was run upon this wheel. The belt passed to the driven wheel at *B*. So far, nothing out of the ordinary had happened. By following the course of the belt, however, it was seen that the driving power was extended from the line *C*, adjoining pulley *B*, to a countershaft. The latter did not have very much work to do as it simply furnished means for propelling an independent machine below, but there was no essential need of this shaft since the machine below could have been driven from a wheel placed upon the main line of shafting.

It was surmised this had not been done because there was no coupling in the main shaft at that point, and it would have been too much trouble to the machinists of the plant to overhaul the main line for the purpose of slipping on a wheel to drive the new machine below. Therefore, the easiest way out of it for the time being was to put up a countershaft. This meant two more bearings to add to the frictional account, for it meant a piece of shafting to turn. All this comes under the head of lost power, as it is unnecessary.

On the same line of shafting was a quarter turn effected by the employment of the upright shaft and wheel at *E*. The driver is marked *D*, and the driven wheel at another angle is shown at *F*. This combination likewise added unnecessary frictional percentage. The whole arrangement simply results in giving to a belt another angle. This angle could be obtained by using a quarter turn belt direct from the main shaft down to the wheel of the machine on the floor, thereby cutting out the power losing factors.

In another manufacturing plant, where a gasoline engine was struggling along with a network of wheels, hangers, shafting and belts, I observed the formation exhibited in Fig. 2. Evidently various bosses of the plant had made individual installations at different periods to accommodate new installations. It was very plain that, as each addition was made, no attention was paid to the mechanical requirements of the original outfit. Hence the condition as shown.

The crank and pin of the gas engine is shown on the first shaft next the top of the diagram—the engine itself is not shown in the cut. The first error was made when two belted wheels were placed on either side of the crank shaft of the engine. In this case the balance wheel was depended upon by using the tight and loose wheels at *A*. This is often done with successful results, but in this particular combination the engine had a mighty struggle to keep things moving regularly. The irregularity of the speed at times was very plain. Every time an additional machine was put on by means of the shifter belt, the whole system slowed down a little. Uneven work of this nature is a strain upon the engine and the entire power system as well. The loss of power in this system was due to the odd arrangement of the wheels and shafting. Wheel *B* had to take a wheel at the angle *C* and drive it with a quarter-turn belt, as shown. This belt was in the habit of running off frequently and caused much trouble. Some sticks were nailed up alongside of the belt to guide it straight, which friction added to the lost power account. Then, again, the combination of driver *A* and *E* meant trouble. The speed had to be reduced to a greater extent than is practicable, resulting in trouble with the cone *G*, which latter cylinder is driven by the belt from the wheel *F*. The cone cylinder had to be turned at an exceedingly slow rate, nevertheless, considerable power was consumed and lost. Finally the entire system was taken down and a belt was run direct from a pulley of small diameter on the main shaft, to the cone, eliminating the intermediate shaft. In fact, about the first thing the expert does is to chop out needless frictional consuming shafting, hangers and parts. These additional parts usually accumulate as time passes. A new man gets on the mechanical force and sees the error of multiple combinations, the results of many men's collections of wheels and belting. Then he makes a new start and piles much of the belting, hangers, shafting and pulleys on the junk heap. Former loss of power is cut out, the system works better, and the engine is given a fairer chance.

Another puzzling collection of wheels, belting, hangers and shafting is shown in Fig. 3. The driving shaft is at the lower part of the

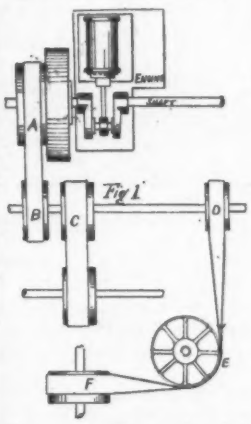


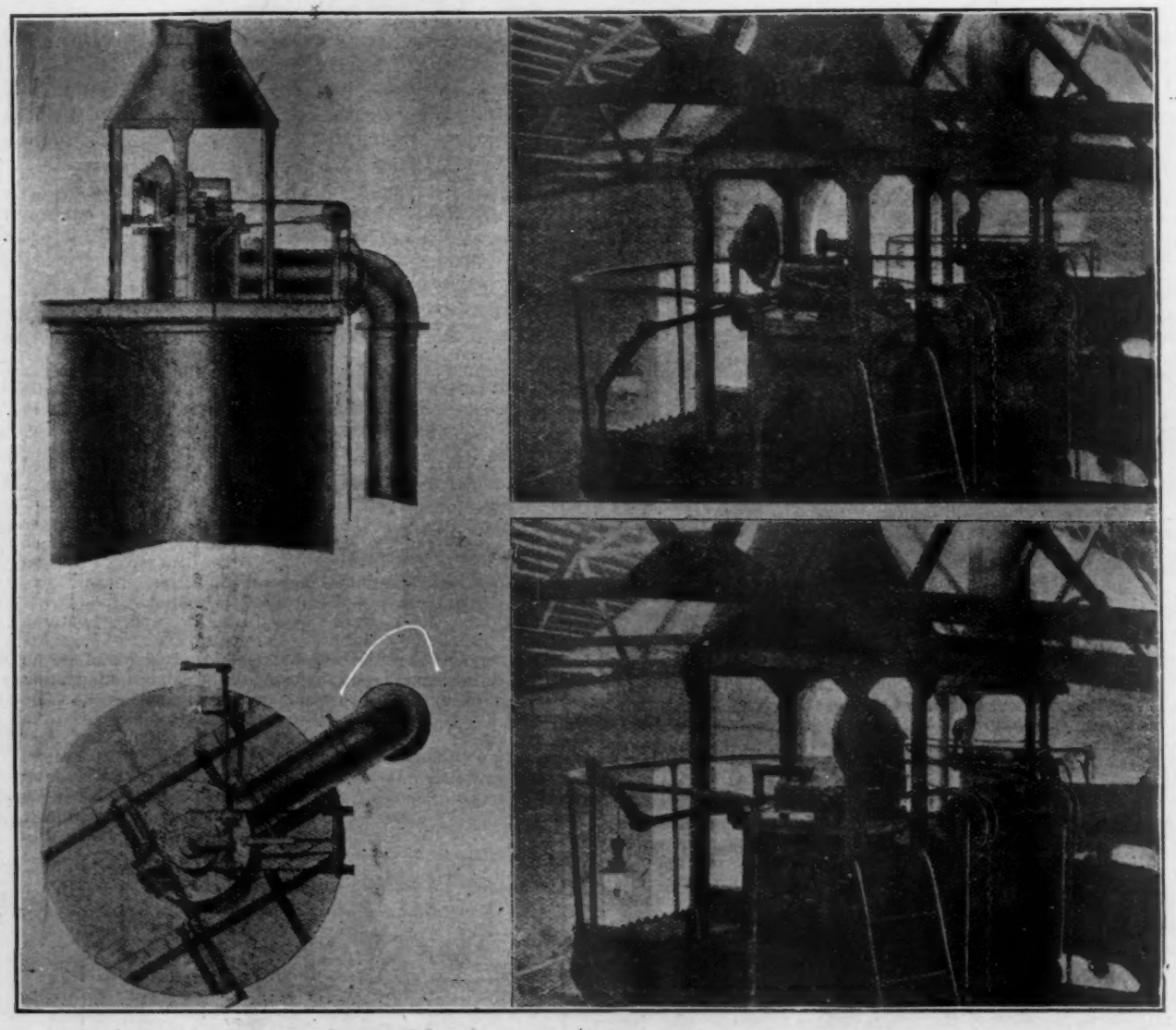
diagram. Is carries drivers *AA*, also *F*. The latter carries the belt to the shafting at an angle at *H*. The belt is sustained in proper line for running by means of the little guide wheel *G*. Any form of device of this nature consumes considerable power. The average workman will strive to avoid using this style of drive, but there are occasions on which a combination of this description cannot be operated without the undesirable parts. In addition to the handicap of the cross belt and angled shaft, the line of shafting carrying wheels *B* and *C* had to utilize power for the turn at *D* to the driven upright shaft at *E*. There is not only loss of power, but danger in this kind of a drive, for the reason that if the belt slips from the wheel *E* it is liable to fall into the belting at *A* and *F* and create trouble.

The Croydon (England) Arrangement of Stack Valves for Carburetted Water Gas Plant.

By MR. JAMES W. HELPS, in *Journal of Gas Lighting.*

I notice in your issue of December 31 a description of an invention patented by Mr. G. W. Bailey, of Folkstone, having for its object the prevention of leakage at the stack valves of carburetted water gas plants.

We have had a very similar arrangement in use at the Croydon works for the past two or three years, which, while having the advantage of being both simpler and less costly than Mr. Bailey's device, is, I think, calculated to do its work somewhat more efficiently, as the whole weight of the valve acts on the seating during the period of rotation, while in Mr. Bailey's plan it seems to me that the action



of the bevel-pinion clearly has a tendency to keep the valve slightly off its seating during the process of "grinding-in."

The drawing and photographs sent herewith will make the process sufficiently clear, without further description. It will, however, be seen that the operator standing on the stage-floor is able, by pulling each chain alternately, to rotate the valve (which is suspended on a loose pivot) one half-turn at each movement, and thus keep the seating thoroughly clean.

The drawing also shows another arrangement which has proved extremely useful. Experience demonstrated to us that during the process of clinkering the in-rush of air at the open doors, when the stack-valve was full open, was so rapid that the heat produced at the bottom of the generator was sufficient not only to cause great inconvenience to the men at work, but also to quickly burn away the cast iron frame immediately over the doors. To overcome this difficulty, we devised a secondary stack-valve, having in it an opening of such a size as would just take away the products of combustion without allowing flame to issue at the doors. Experiment showed that the most suitable size for this opening was about 4 inches in diameter.

This stack-valve was worked from the stage floor, and in much the same way as the ordinary valve. I need hardly say that, before closing it, it is necessary to open the valve at the bottom of the generator, and also the clinkering doors.

I think the drawing is sufficiently clear to render any further description unnecessary.

I may, in conclusion, say that neither of the above arrangements is patented, and it is not at all unlikely that other gas engineers have similar devices of their own for overcoming the same difficulties.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

JUDGE T. C. MUNGER has appointed Mr. H. G. Leigh, of Nebraska City, Neb., Receiver for the Nebraska City Gas and Light Company, at the instance of the Illinois Trust and Savings Company, of Chicago.

MR. E. M. STACK has been appointed Superintendent of the Scranton (Pa.) Gas and Water Company, vice Mr. Robert Reeves, deceased.

AT the annual meeting of the South Haven (Mich.) Gas Company the following result was reached: Directors, A. B. Connable, C. A. Peck, S. Van Ostrand, A. C. Runyan and C. A. Runyan; President, A. C. Runyan; Vice-President, C. A. Peck; Secretary and Treasurer, S. Van Ostrand; Manager, C. A. Runyan.

A FAIR appeal seems that of the residents of Rockaway Beach and points further west in the district of the Queens Borough (L. I.) Gas and Electric Company, who ask for the locating of a branch office in the settlement on the Beach proper. As it now stands the main offices of the Company are in Far Rockaway, with the result that possibly 40 per cent. of the Company's customers have to travel 2 miles or more to make their peace with the Company's receiving tellers.

AT the annual meeting of the Chattanooga (Tenn.) Gas Company, which property is under the progressive management of Messrs. Child, Hulswit & Co., it was decided to expend $150,000 on plant betterment, to include additional water gas sets and a holder up to retaining 1,000,000 cubic feet. The Company's business is expanding in a most gratifying way.

MR. P. J. NEVINS, of the Haverhill (Mass.) Company, has been trying to convince the residents of Middleboro (which busy settlement is not far from Middleboro) that they need a gas supply. His pertinacity seems to have won out, through an appeal to the Business Men's Club of the named place. Mr. Nevins went before that body and, in an argument that carried plenty of forcefulness, convinced them that he could lead them to the light.

MR. CHARLES H. WILLIAMS, General Manager of the La Crosse (Wis.) Gas and Electric Company (he is a graduate of the Engineering School, University of Wisconsin, Class of 1896) has been appointed Lecturer in the Extension Division of the University, and will assist in the organization and management of the Correspondence Study Class in La Crosse. Good enough.

AT the annual meeting of the New Britain (Conn.) Gas Company, these officers were elected: President, A. J. Sloper; Secretary and

Treasurer, H. T. Sloper; Directors, A. J. Sloper, H. E. Russell, John Walsh, E. N. Stanley and F. M. Travis.

MR. J. L. HUDSON has been elected to the vacancy in the Board of Directors of the Detroit (Mich.) City Gas Company occasioned by the death of Mr. Joseph H. Berry.

MR. N. CURTIS FLETCHER has resigned all active connection with the United Illuminating Company, of Belfast, Me. Mr. H. W. Balloou, of Providence, R. I., has been elected Secretary and Treasurer to the Company.

AT the annual meeting of the shareholders of the Washington (D. C.) Gas Light Company no change was made in the executive management.

AT the annual meeting of the Pittsfield (Mass.) Coal Gas Company the following officers were elected: President, Hon. Charles H. Carpenter; Cierk, U. S. Drake; Treasurer, H. B. Fischer; Superintendent, N. M. Batchelder.

"A. O. H.," writing from Decatur, Ills., under date of the 4th inst., says: "Mr. W. L. Powers, the up-to-date Superintendent of the gas departments of Decatur and Champaign, Ills., entertained the Directors and salesmen of the Mueller Manufacturing Company, during the annual meeting of the Mueller Company's sales' staff, with a demonstration of gas works' tools, etc., accompanied by a practical talk on the manufacture of gas. The Mueller Company is now listing gas works' tools in the new catalogue, so the trip through the gas works was instructive and interesting to the 35 members of the Mueller staff who made it."

MESSRS. BIOREN & Co., of Philadelphia, are offering $1,500,000 convertible collateral trust bonds due October 1, 1914, the issue being a direct obligation on the properties of the American Gas Company. The price asked is par and interest—the latter is at the rate of 6 per cent. per annum.

As an example of the way in which the Peoples Gas Light and Coke Company, of Chicago, does its advertising we may mention that the entire 9th page of the Chicago *Daily Tribune* for the 27th ult., was given over to an illustrated listing of the uses to which gas can be successfully and economically put.

THOSE competent to so say declare that the authorities of Fort Wayne, Ind., and the Fort Wayne Gas Company have reached an agreement under which the Company agree to sell gas at 95 cents per 1,000 cubic feet until 1910, the succeeding rate to be 85 cents per 1,000 until December 31, 1915.

THE New York *Herald* of recent date said that notice of its intention to extend its operations through Manhattan and Bronx Boroughs, New York, has been served by the Long Acre Electric Light and Power Company through an application filed with the Public Service Commission asking the approval of that body of a proposed issue of $10,000,000 preferred stock and $50,000,000 bonds. This step follows the long legal battle in the courts between the Company and the Consolidated Telegraph and Electrical Subway Company, in which contest the Long Acre Company was partially successful.

MR. J. OAKLEY CORSON has been appointed Manager of the sales' promotion department of Messrs. Edward M. Deane & Co.

MR. H. A. ROSE has been appointed Appeal Agent by the Fort Scott (Kas.) Gas and Electric Company. This is a new designatory term for a position that now goes regularly with the office force of every fairly large gas company. Mr. Rose will be the recipient of the complaints of consumers, and having heard the complaint it is up to him to prescribe the remedy.

RATHER belated mention this is, but at the annual meeting of the Manchester (N. H.) Gas Company the officers elected were: President, George H. Chandler; Clerk, Nathan P. Hunt; Treasurer, Walter M. Parker.

UNDER a decree of Judge Waddill, of the United States Circuit Court for the District, the Receivers of the Suffolk (Va.) Gas Company have been authorized to issue receivership certificates in the sum of $30,000 for the completion of the plant.

THE February meeting of the New York Section of the Illuminating Engineering Society, which was held in the United Engineering Societies Building, 33 West 39th street, on Thursday evening last, was well attended, and those present were well repaid in the paper presented by Mr. George Leland Hunter, the theme of which was "Light and Color in Decoration." The author treated the subject from the standpoint of the decorator, and although in one instance his results were not altogether indorsed by his hearers, in the main they were with him; as to theory, at least.

THE contest for control in the Nashville (Tenn.) Gas Company's management is a very lively one. The annual meeting is set for the 11th prox. It is asserted that the present management is not as active in its attempts to take business from the local electric lighting concern as it might be; but whether this is so or not, it is matter for comment by visiting gas men that the physical condition of the Gas Company's plant is far from being what it should be.

MR. LOUIS N. RANCKE, the clever little gentleman who "travels" for the Baltimore Retort and Firebrick Company, seems to have been up-and-doing recently, as the following matters gathered in by him in the last 20 days go to show: Renewals of 8 benches of 6's in the Richmond (Va.) generating house; renewals of 4 benches at Greensboro, N. C., and a complete, new half-depth bench of 6's for Cambridge, Md.

"R. G. F.," incloses the following from Schenectady, N. Y., under date of the 7th inst.: "A large number of engineers attended the meeting of the Schenectady branch, American Institute Electrical Engineers, in the Schenectady High School last, evening. Mr. H. H. Suplee, Editor of *Cassier's Magazine*, delivered a lecture, illustrated by stereopticon views, on 'Gas Power,' which was both educational and interesting. He spoke first on what had been done with gas power in the generating of electric currents, and thought that fruition of greater studies in this direction were close at hand. He said that France was doing and is doing more for the advancement of the use of the gas engine than any other country, and was now utilizing gas from blast furnaces for larger gas engines than were heretofore thought practical. Ever since the steam turbine became practically useful in the generation of electricity engineers had devoted much attention to experimentation in connection with gas turbines. This, again, was especially true of the French engineers. 'In fact,' said Mr. Suplee, 'To France must go the honor of building the first practical gas turbine, a 300-horse power turbine having been recently built in that country, which scientists acknowledge is a practical success.'"

DURING the year 1907 the Washington (D. C.) Gas Light Company, in accounted for output, distributed 1,852,609,900 cubic feet; it paid out during the same period in direct taxes the sum of $119,456.80; its consumers numbered 44,792; its employees numbered 641; it paid out on labor account $322,286.04; and its stock stands in the names of 1,097 individual shareholders.

"M. D. V., writing from Richmond, Va., under date of the 6th inst., incloses the following: "Estimating the receipts of the Richmond municipal gas works for 1907 in round numbers at $365,000, a reduction in the price of 10 per cent. would mean a shrinkage in receipts of $36,500; and a flat rate of 80 cents would equal $73,000. The recommendation of the Committee on Light provides, however, for three propositions: 90 cents for cooking and illuminating purposes; 85 cents for manufacturers, and 85 cents for all gas where the monthly bills amount to more than $50. Just how this will affect the revenue can be determined only after careful examination of the books, to show the amount used by manufacturers and the monthly bills of more than $50. Superintendent Knowles is having this report prepared, so that the Council may secure exact information on the subject. In Richmond there are 10,948 meters, which supply about 60,000 persons. The old city proper has a regular network of mains and pipes. Extensions are being made through many sections of the annexed territory. Superintendent Knowles, who is familiar with every detail of the work, has long been of the opinion that the city could afford to sell the product at a less figure than $1 per 1,000 cubic feet. He believes, however, that it is best to begin the reduction gradually, scaling rates every year. The net profits last year were $163,000, this record being considered remarkably good when the quality of the gas maintained an average of 25.50-candle power for the entire 12 months."

"Two bills enlarging the powers of the Western Maryland Gas Company, so says the Baltimore *News*, were introduced in the Maryland Senate the first week in the current month, both being sponsored by Mr. Shannon. One bill is designed to give the Company the right to pipe from Cumberland to Hagerstown; the other changes the general law so as to give it the right to go *anywhere* in the State. What makes one doubly suspicious of the purpose of the parties behind this amending scheme is their loud protestation of a lack of desire to enter the city of Baltimore. Verily, they protest too much! L. M."

FROM the best figures at command it is seen that the consumption of natural gas in the Pittsburgh (Pa.) district for the year 1907 reached the enormous total of 100,000,000,000 cubic feet on all account and purpose. This was an increase over that used in 1906 of 10 per cent.

THE City Council of Fort Worth, Tex., has adopted an ordinance to the effect that, beginning April 1st next, the Fort Worth Light and Power Company shall charge not to exceed $1.25 per 1,000 cubic feet for gas, prompt payment (within 15 days) to entitle the user to a rebate of 10 per cent.

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

THOS. J. CUNNINGHAM,
ELBERT P. CALLENDER,
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NOTIFICATION RESPECTING ADVERTISING.

Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Company, 39 and 41 Chambers street.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime street, London.

MONDAY, FEBRUARY 17, 1908.

The Market for Gas Securities.

Continued dullness ruled in city gas shares, and it may be said still rules; and the main trouble is that weakness goes with the dullness. Consolidated opened this morning (Friday) at 95 to 97. Transactions in the shares are few. Old time gas investors will hear with regret of the death of Mr. Frank T. Hewitt, who 20 years or more ago was one of the best known gas stock brokers in the country. He was a nephew of ex-Mayor Hewitt, and in the early '70's was largely interested in New York city street railroads. Somewhat eccentric in manner, it goes that underneath his eccentricity was the spirit of a man whose charitable impulses were many and effective.

The general gas share market is weak, especially in respect of Peoples, of Chicago. In reality everything points to its being one of the best investment offerings on the list.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

FEBRUARY 17.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	95	97
Central Union Gas Co.—				
1st 5's, due 1927, J. & J	3,000,000	1,000	92	97
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	—	105
Mutual	3,500,000	100	—	170
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	85	90
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	98	104
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	90	98
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	100	105
Con. 5's, due 1945, J. & J.	1,500,000	—	97	101
Standard	5,000,000	100	70	100
Preferred	5,000,000	100	100	125
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	100	105
The Brooklyn Union	15,000,000	1,000	90	100
1st Con. 5's, due 1948, M. & N.	15,000,000	—	91½	92
Yonkers	299,650	500	130	—
Out-of-Town Companies.				
Bay State	50,000,000	50	½	¾
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	65
" 1st Mtg. 5's	500,000	1,000	95	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
" " Bonds, 5's	5,250,000	1,000	63	66
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,660,000	1,000	104	105¼
Cincinnati Gas and Electric Co.	29,500,000	100	93	93¼
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	98	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	87	88
Preferred	3,026,500	100	81	82
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	—	90
Mortgages, 6's	3,600,000	—	—	118
Chesapeake, 1st 6's	1,000,000	—	—	—
Equitable, 1st 6's	910,000	—	—	—
Consolidated, 1st 5's	1,490,000	—	—	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	—	—	100
Detroit City Gas Co.	6,000,000	50	—	50
" Prior Lien 5's	4,618,000	1,000	—	98
Detroit Gas Co., 5's	381,000	1,000	75	80
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	39	40
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Lt. Co., 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	100	105
" Bonds, 5's	10,500,000	—	101	102½
Indianapolis	2,000,000	—	60	70
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	30
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	97	97¼
Preferred	2,500,000	100	92¾	93
Bonds	10,000,000	1,000	104	104¼
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	106	108¾
" 6 per cent. scrip, due 1910	100,000	25	60	60½
Massachusetts Gas Companies, of Boston	25,000,000	100	52½	—
Preferred	25,000,000	100	82½	—
Montreal, Canada	2,000,000	100	218	218¾
Nashville Gas Lt. Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	56	58
Bonds, 6's	6,000,000	—	137	138
New Haven	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	23,000,000	100	80½	81½
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Elec. Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104½	105½
San Francisco, Cal.	15,500,000	—	—	—
St. Joseph Gas Co.—				
1st Mtg. 5's	751,000	1,000	22	—
St. Paul Gas Light Co.	1,700,000	100	45	47
1st Mortgages, 6's	600,000	1,000	113	114
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	90¼	—
Syracuse, N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	103	—
Washington, D. C.	2,600,000	20	340	345
1st Mortgage, 6's	600,000	—	—	—
Western, Milwaukee	4,000,000	—	—	—
Wilmington, Del.	600,000	50	230	—

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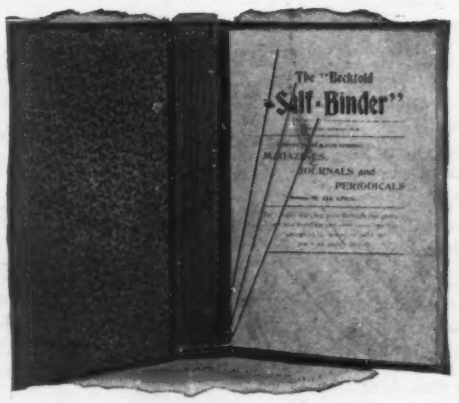

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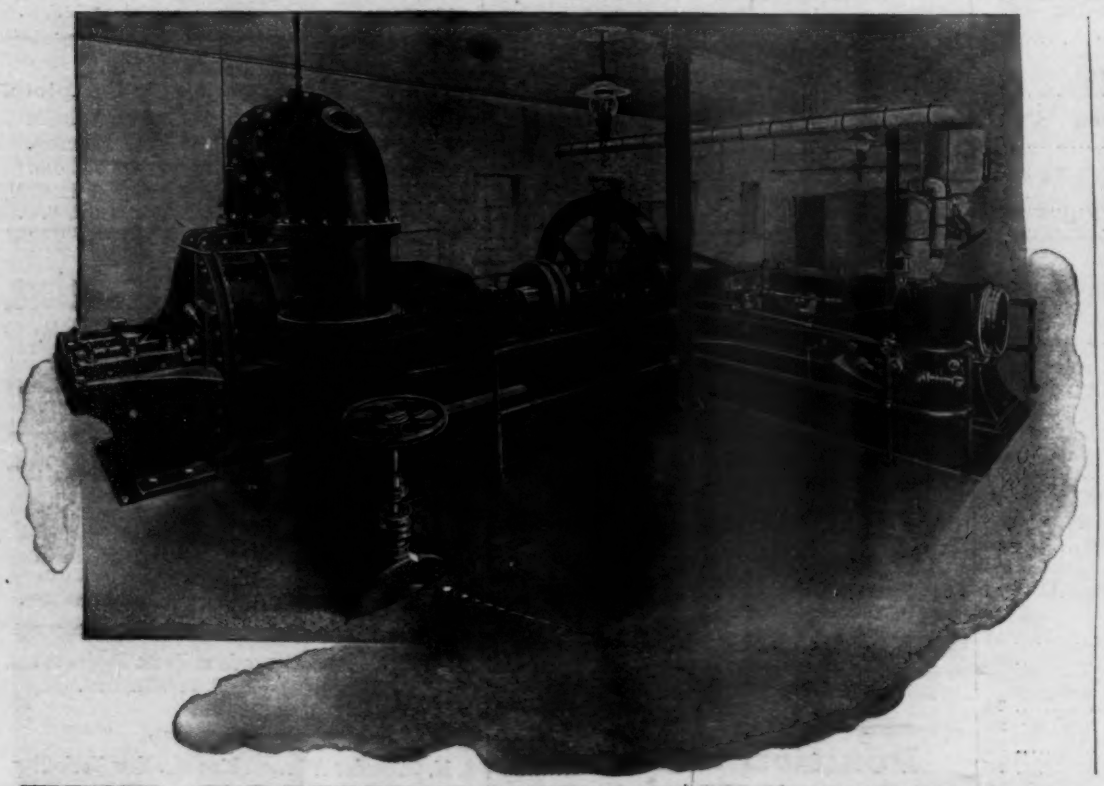

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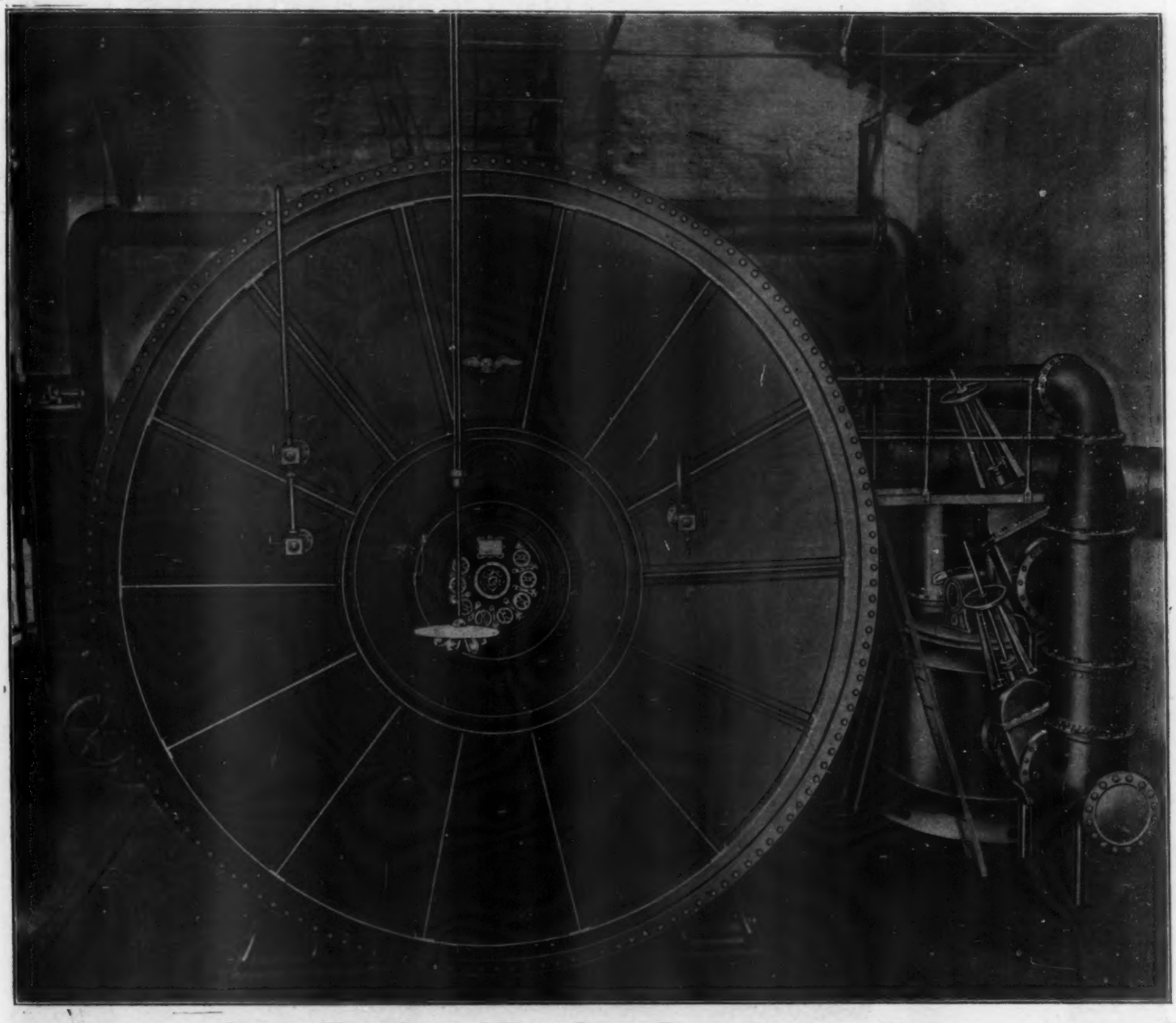

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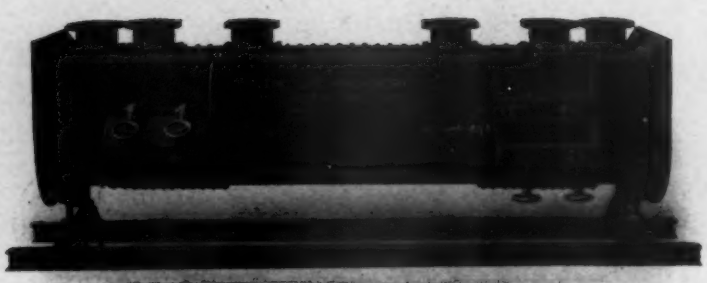

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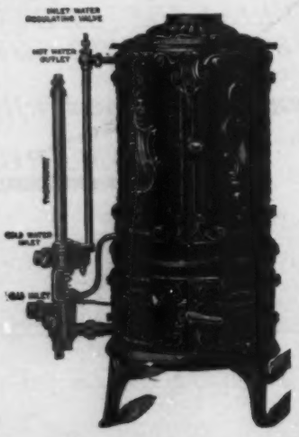

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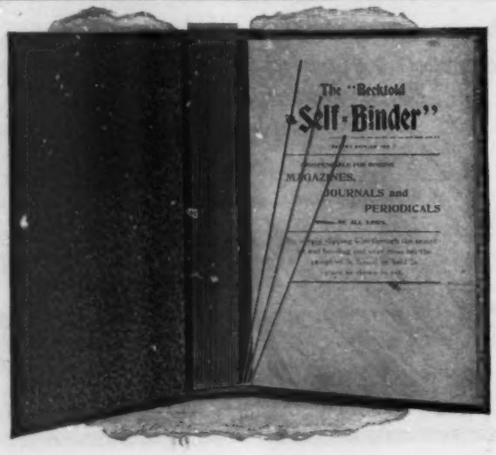

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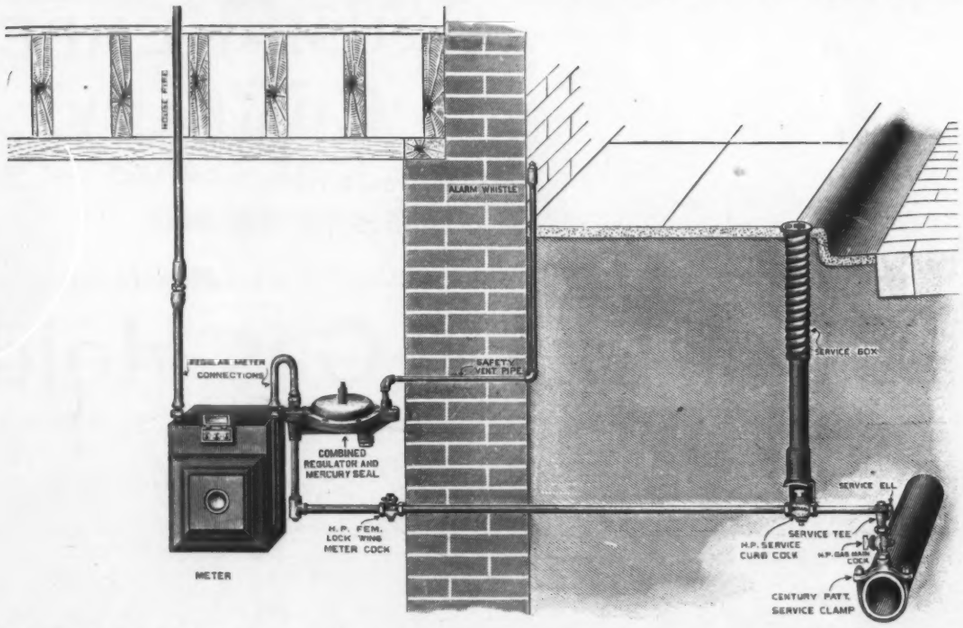

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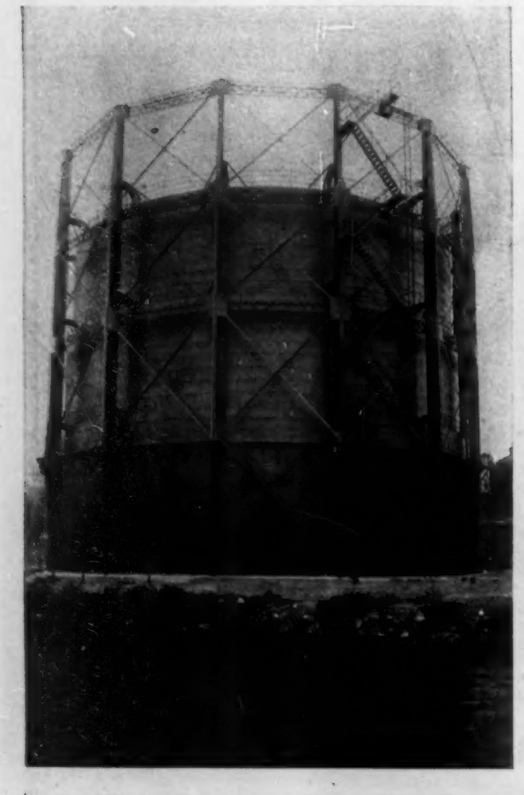

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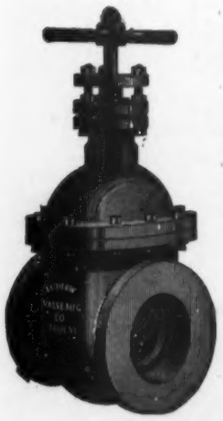

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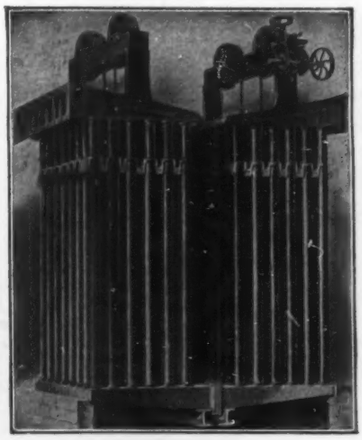

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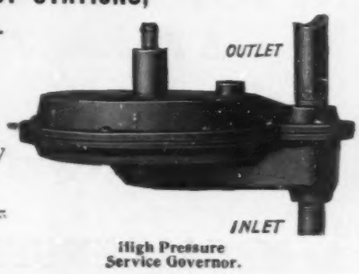

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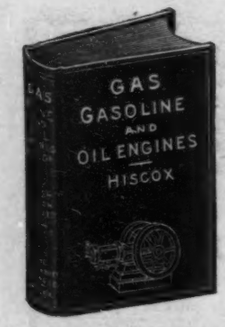

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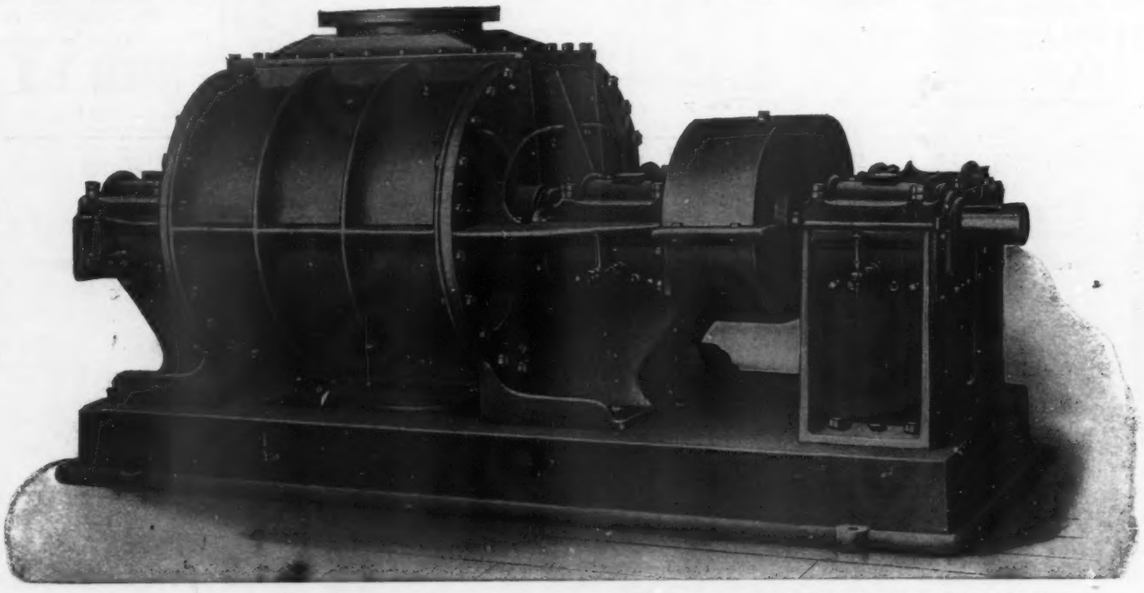

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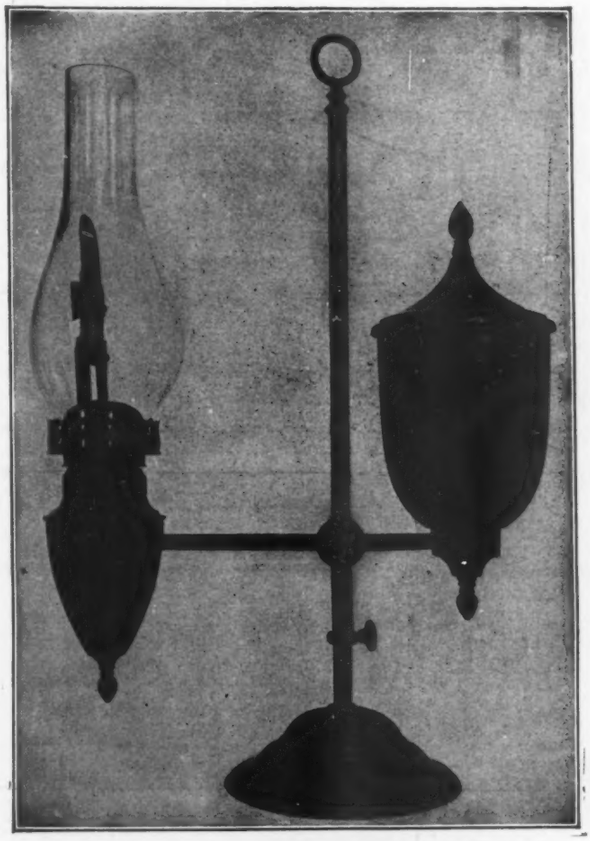
MARCH, 1908.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.
Sun.	1	6.20 PM	5.30 AM
Mon.	2	6.20 NM	5.30
Tue.	3	6.20	5.30
Wed.	4	6.20	5.30
Thu.	5	6.20	5.30
Fri.	6	6.20	5.30
Sat.	7	10.40	5.30
Sun.	8	11.40	5.20
Mon.	9	12.40 AM FQ	5.20
Tue.	10	1.30	5.20
Wed.	11	2.20	5.20
Thu.	12	3.10	5.20
Fri.	13	3.40	5.20
Sat.	14	4.20	5.20
Sun.	15	4.50	5.10
Mon.	16	No L.	No L.
Tue.	17	No L. FM	No L.
Wed.	18	No L.	No L.
Thu.	19	6.40 PM	8.50 PM
Fri.	20	6.40	9.50
Sat.	21	6.40	11.00
Sun.	22	6.50	12.00
Mon.	23	6.50	1.10 AM
Tue.	24	6.50	2.10
Wed.	25	6.50 LQ	3.20
Thu.	26	6.50	4.10
Fri.	27	6.50	4.50
Sat.	28	6.50	4.50
Sun.	29	6.50	4.40
Mon.	30	6.50	4.40
Tue.	31	6.50 NM	4.40

TOTAL HOURS DURING 1908.

By Table No. 1.

	Hrs.Min.
January	228.30
February	187.30
March	192.00
April	160.10
May	155.10
June	138.00
July	155.50
August	173.40
September	185.20
October	214.00
November	218.10
December	226.40
Total, yr.	2235.00



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10-Candle Power.

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1st. It uses Standard Kerosene Oil (Pratt's Astral Oil or equivalent).

2d. It is remarkably steady. Will burn 24 hours continuously with less than 2 per cent. variation.

3d. It is much less dangerous than Pentane, which is a kind of gasolene.

4th. It is not easily affected by air currents in the photometer room.

5th. Since the lamp may burn continuously, the candle power of gas may be taken at any moment, if necessary. This insures steady illuminating power without waste of carburetting material.

6th. The first cost of the lamp brings it within the reach of even small gas works.

7th. Costs much less to maintain than a Pentane lamp or sperm candles doing the same service.

8th. Is not affected by the weather.

PUBLIC LIGHTING TABLE.

MARCH, 1908.

Day of Week.	Date.	Table No. 2. New York City. All Night Lighting. Complete Lighting in One Hour	Complete Extinguishing in 50 Minutes
		From Time Given	
		P. M.	A.M.
Sun.	1	5.22	5.32
Mon.	2	5.22	5.27
Tue.	3	5.22	5.27
Wed.	4	5.22	5.27
Thu.	5	5.32	5.17
Fri.	6	5.32	5.17
Sat.	7	5.32	5.17
Sun.	8	5.32	5.17
Mon.	9	5.32	5.17
Tue.	10	5.32	5.17
Wed.	11	5.32	5.17
Thu.	12	5.42	5.07
Fri.	13	5.42	5.07
Sat.	14	5.42	5.07
Sun.	15	5.42	5.07
Mon.	16	5.42	5.07
Tue.	17	5.42	5.07
Wed.	18	5.42	5.07
Thu.	19	5.52	4.57
Fri.	20	5.52	4.57
Sat.	21	5.52	4.57
Sun.	22	5.52	4.57
Mon.	23	5.52	4.57
Tue.	24	5.52	4.57
Wed.	25	5.52	4.57
Thu.	26	5.57	4.47
Fri.	27	5.57	4.47
Sat.	28	5.57	4.47
Sun.	29	5.57	4.47
Mon.	30	5.57	4.47
Tue.	31	5.57	4.47

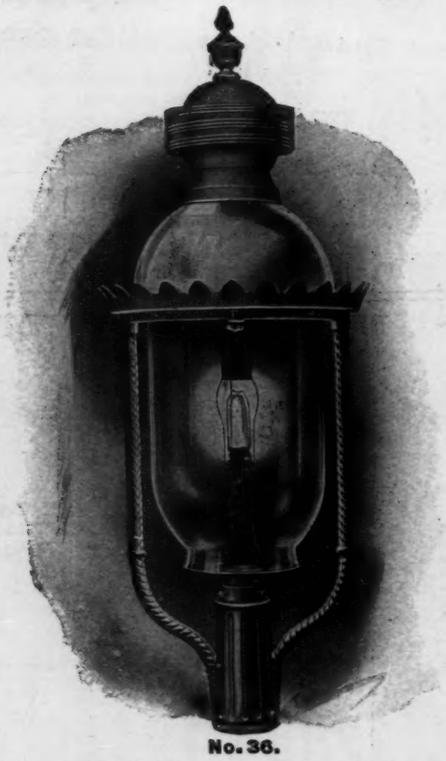
TOTAL HOURS DURING 1908.

	Hrs.Min.
January	481.50
February	329.15
March	351.50
April	341.50
May	233.05
June	218.10
July	282.55
August	254.55
September	292.25
October	420.45
November	374.30
December	411.05
	3992.35
Deduct on account of 50 min. extinguish'ng time	30.30
Total, yr.	3962.05

NEW YORK, 318 West 42d Street.
BOSTON, 820 Beacon Building.
PHILADELPHIA, Broad and Arch Streets.
ST. LOUIS, 712 Roe Building.
CHICAGO, 218 La Salle Street,
SAN FRANCISCO, 612 Oak Street.

WELSBACH STREET LIGHTING COMPANY

....OF AMERICA....



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Which includes its specially DESIGNED and PATENTED BURNER for PARK LIGHTING exclusively.

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By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

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IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

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No. 38.

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For decorative appearance and large volume of light at a popular price to the consumer,

THE CHIC LIGHT

is practically alone in the field. Complete satisfaction to the user is its strong point.

THE CHIC LIGHT—Design No. 71310.

PRICES:

Boxed complete, with No. 71 Welsbach burner, No. 310 F. Q. M. cylinder, No. 196 Junior J Brand Welsbach mantle, including the No. 316 opal shade, which will be packed separately.

Price, complete, clear cylinder, each, dozen lots, ... $1.35
Price, complete, clear cylinder, 100 lots, each, ... 1.25

When supplied with **No. 310 F. Q. M. Opal Cylinder** add 10 cents to above list.

Price of Shade No. 316.
Package Contains 16 Dozen.

Price, per dozen, ... $4.40
Price, original package, per dozen, . 4.00

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Nashua, N. H.
Augusta, Me. (2d contract).
Everett, Mass.
Jenkintown, Pa. (2d contract).
Coney Island, N. Y.
Mexico, Mo.
Jacksonville, Fla.
Syracuse, N. Y. (2d contract).
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Holyoke, Mass.
Peoria, Ills.
Schnectady, N. Y. (2d contract).
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Galveston, Tex. (2d contract).
Quebec, Canada.
Indianapolis, Ind. (2d contract).
Bessemer, Ala.
Waterbury, Conn. (5th contract).
Sioux Falls, S. D. (3d contract).
Philadelphia, Pa.
New Hartford, Conn.
Poughkeepsie, N.Y. (2d contract).
Nashville, Tenn.
Salisbury, Md.
Norfold, Va. (4th contract).
Wallingford, Conn.
Richmond, Va. (2d contract).
Oak Bluffs, Mass.

TOTAL SETS INSTALLED DURING YEAR, ... 43
TOTAL SETS INSTALLED TO DECEMBER 31, 1907, ... 677
TOTAL DAILY CAPACITY, TO DECEMBER 31, 1907, ... 545,865,000 cu. ft.

Tar Extractors for Carburetted Water Gas.
Photometrical Apparatus.
Gas Analysis Apparatus.
Recording Gauges.
Straight Standpipe System for Coal Gas Retorts.
Straight Standpipe Cleaners.
Waste Heat Boiler.
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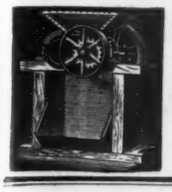

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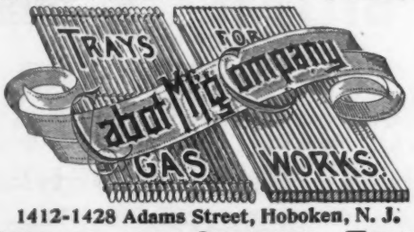

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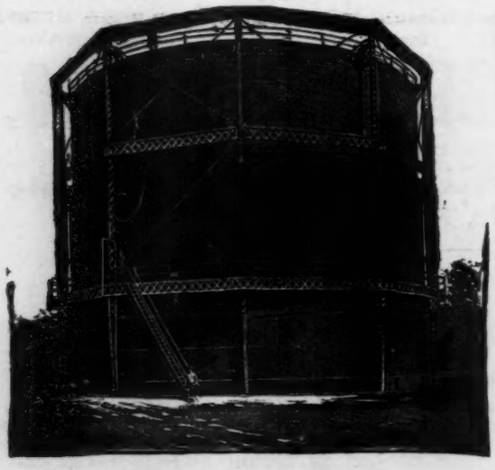

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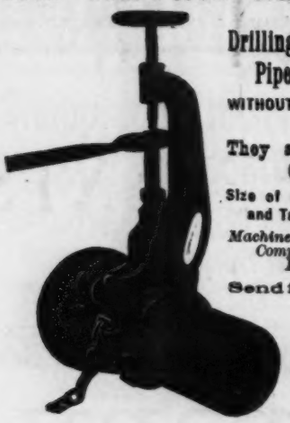

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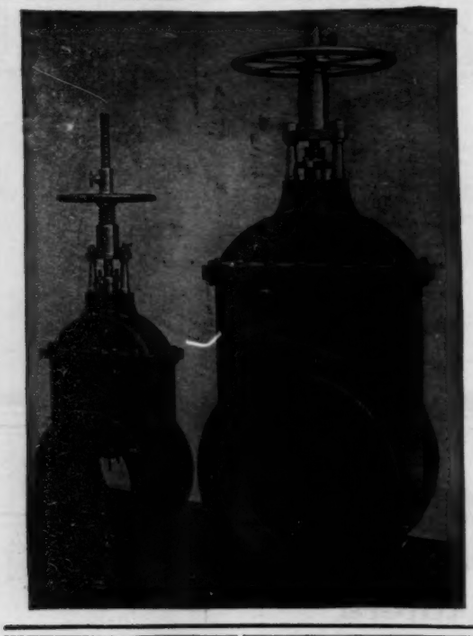

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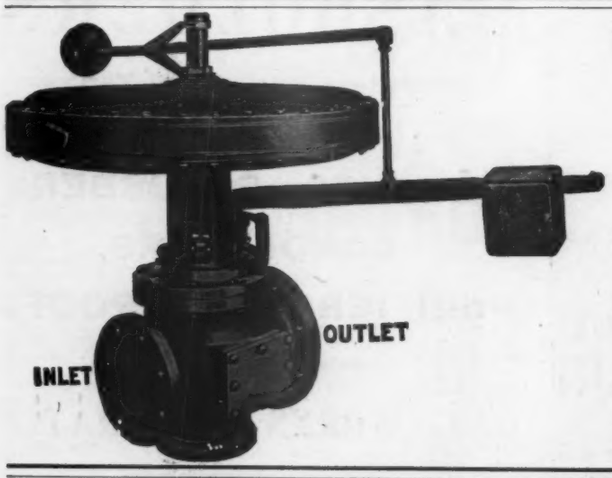

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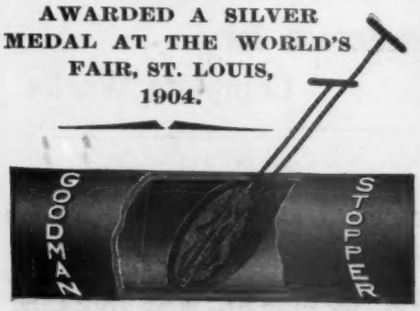

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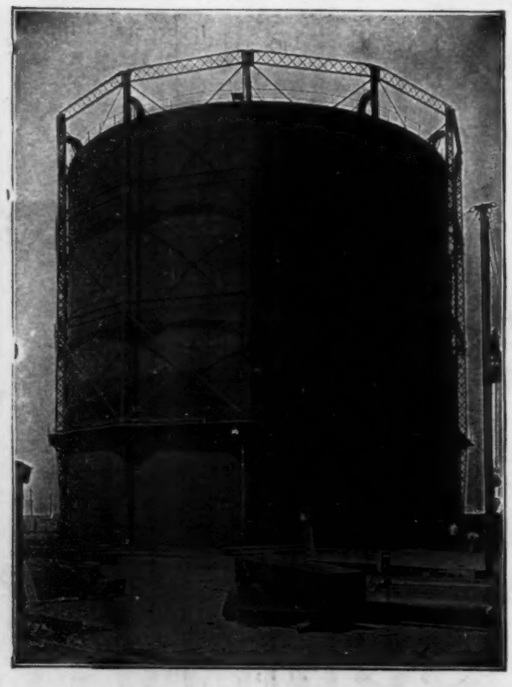

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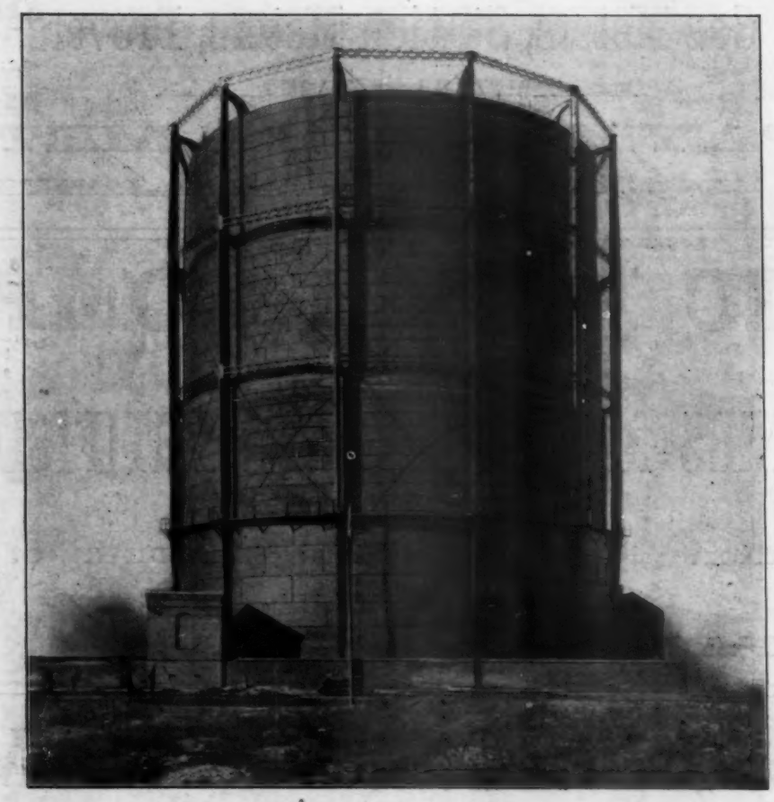

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